

## **APPENDIX B**

### **RESULTS OF THE THIRD PALEONTOLOGICAL FIELD SURVEY OF ABANDONED MINE SITES NEAR CAMERON, ARIZONA**

**RESULTS OF THE  
THIRD PALEONTOLOGIC FIELD SURVEY  
OF ABANDONED URANIUM MINE SITES  
IN THE NAVAJO NATION  
NEAR CAMERON, ARIZONA**

by

Randy E. Kirby  
Patty Rubick Luttrell  
Michael Morales

Museum of Northern Arizona  
Route 4, Box 720  
Flagstaff, Arizona 86001  
(602) 774-5211

under

Professional Service Agreement Number C20554

with

The Navajo Nation  
Abandoned Mine Land Reclamation Department  
P. O. Box 730  
Tuba City, Arizona 86045  
(602) 283-4845

April 30, 1992

## TABLE OF CONTENTS

	<u>Page</u>
Introduction . . . . .	1
Methods. . . . .	3
Stratigraphic Positions of the Mine Sites . . . . .	4
Geologic Description of Mine Sites and Discussion of Paleontologic Resources. . . . .	7
Site NA-0155 a, b (Charles Huskon No. 10). . . . .	7
Site NA-0163 (Ryan No. 1) . . . . .	10
Site NA-0166 <sup>Charles</sup> <del>(Huskon)</del> No. 11) . . . . .	13
RAMCO Complex (= sites 72a,b, 73, 74, 75). . . . .	15
Site NA-0172 a, b (RAMCO No. 21). . . . .	17
Site NA-0173 (RAMCO No. 22) . . . . .	20
Site NA-0174 (RAMCO No. 20) . . . . .	22
Site NA-0175 (Ryan No. 2) . . . . .	24
Site NA-0179 (Yazzie No. 1) . . . . .	26
Site NA-0180 ( Yazzie No.2 ) . ✓ . . . .	28
Recommendations for Protection of Paleontologic Resources During Mine Reclamation . . . . .	30
Mitigation Criteria . . . . .	30
Salvage . . . . .	30
Monitoring . . . . .	30
Exclusion. . . . .	31
Mitigation Recommendations. . . . .	31
Site NA-0155 a, b . . . . .	31
Site NA-0163. . . . .	32
Site NA-0166. . . . .	32

Site NA-0172 a, b . . . . .	32
Site NA-0173. . . . .	33
Site NA-0174. . . . .	33
Site NA-0175. . . . .	33
Site NA-0179. . . . .	34
Site NA-0180. . . . .	34
Table 1: Summary of Recommended Mitigation . . . . .	35
References . . . . .	36
Appendix: Copy of paleontologic survey permit from the Navajo Nation Minerals Department . . . . .	37



1

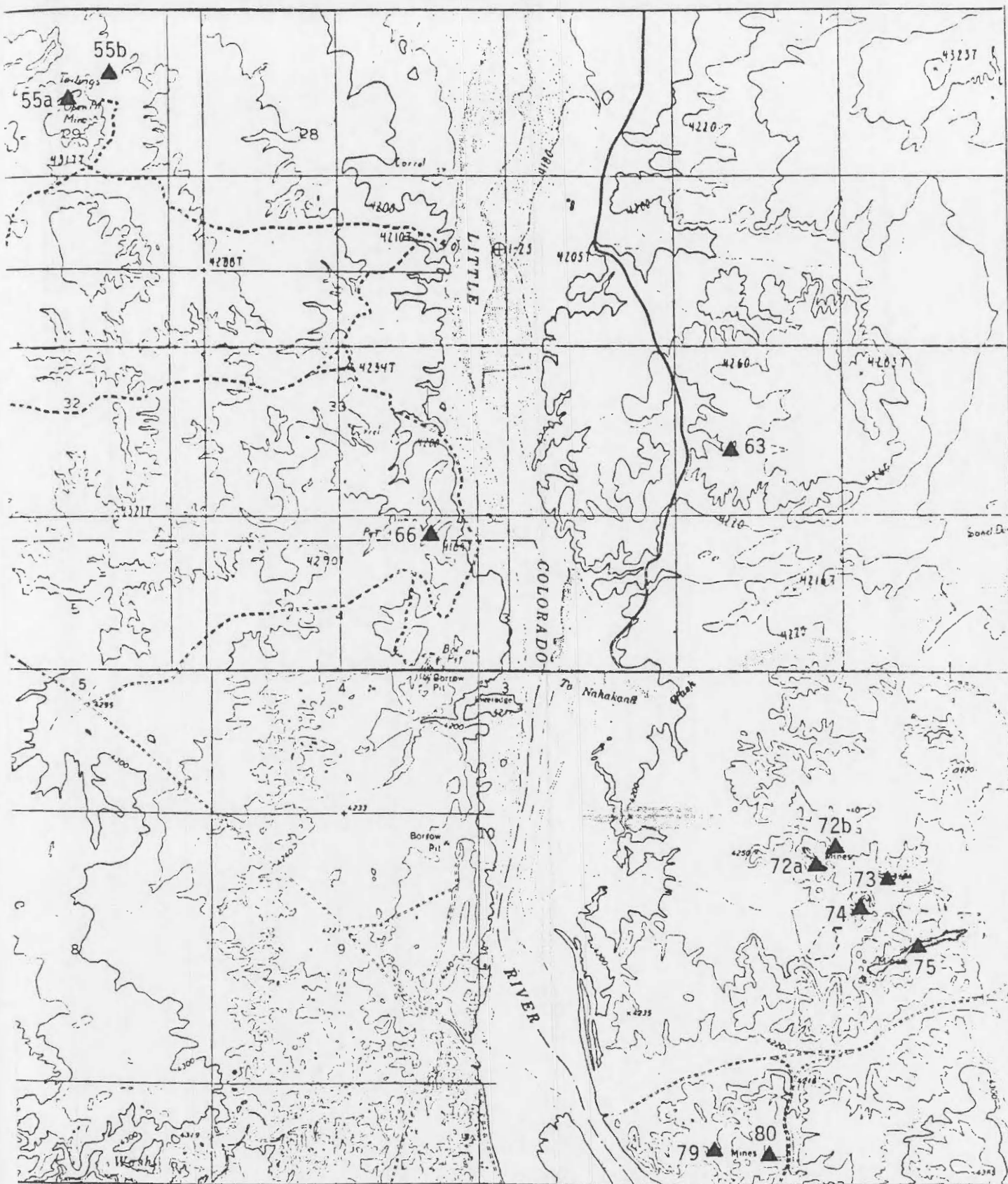
RESULTS OF THE THIRD PALEONTOLOGIC FIELD SURVEY  
OF ABANDONED URANIUM MINE SITES  
ON THE NAVAJO NATION NEAR CAMERON, ARIZONA

INTRODUCTION

Pursuant to federal requirements, the Navajo Abandoned Mine Land Reclamation Department (NAMLRD) at Tuba City, Arizona will undertake reclamation of a number of abandoned open pit mine sites in the area of Cameron, Arizona. The task forms part of a larger project involving mine lands throughout the Navajo Nation. Reclamation will involve in-filling of existing open pits by remnant overburden with concurrent burial of all radioactive waste\*. The NAMLRD has contracted the Museum of Northern Arizona, Flagstaff, to conduct paleontologic field surveys of abandoned open pit uranium mine sites in the area around Cameron. Previous surveys were completed in July, 1991 and March, 1992 (Kirby et al., 1991; Luttrell et al., 1992).

The present report describes the results of a third field survey of an additional nine mine sites that was conducted during April, 1992. The sites are: NA-0155 a,b; NA-0163; NA-0166; NA-0172 a,b; NA-0173; NA-0174; NA-0175; NA-0179; NA-0180 (see Map 1). For ease in referring to the various mine sites, an abbreviated form of their number will occasionally be used. Thus, site NA-0163, which includes only one pit with surrounding waste piles, may be referred to simply as site 63; site NA-0155, which includes two separate subsites each of which contains a pit, may be referred to as 55a or 55b.

\* Some rock uranium waste piles



Map 1. Locations of abandoned uranium mine sites covered by this report. Sites are indicated by the abbreviated version of their number. Some sites have two subsites, indicated by letters after the numbers. (From 7.5 minute topographic maps: top half = Cameron S.E., 1988, provisional; bottom half = Wupatki N.E., 1969.)

This report briefly describes the lithology and sedimentology of each mine site, provides identifications for collected specimens, discusses the significance of the paleontologic resources collected at each site, and makes recommendations concerning the protection of in-situ fossil remains and of potentially fossiliferous strata during future mine reclamation operations.

#### METHODS

Fieldwork consisted of an initial brief reconnaissance of the sites (and subsites), followed by a detailed paleontologic survey of each open pit mine, surrounding low-grade uranium waste piles, and overburden removed by the mining operation. All macrovertebrate bone exposed on the surface as float was collected, and all fossil localities were mapped. Occurrences of in-situ fossil bone and petrified logs and log clusters were plotted on field maps, and dimensions and orientations of logs were recorded.

Vertebrate specimens occurred as surficial float or as diffuse partially buried specimens within the waste piles or in undisturbed outcrop. Lateral reconnaissance at several sites revealed bone occurring within undisturbed strata at the same stratigraphic level as the mine sites. In-situ fossils too large or too delicate to remove during the survey of a site were protected with consolidants and preservatives and left in place for extraction during follow-up mitigation.

Analysis of collected specimens consisted of the preliminary taxonomic identification of fossils for subsequent cataloging and storage in the Museum of Northern Arizona's paleontological collections. The Museum holds these specimens in trust for the Navajo Nation. Lithology (field descriptions), sedimentary structures, paleocurrents, color of strata, and topographic relations were used to determine the relative stratigraphic position of each site and associated fossiliferous layers.

#### STRATIGRAPHIC POSITIONS OF MINE SITES

The present survey focused on nine open pit mine sites east of Black Point, on the western and eastern banks of the Little Colorado River, as shown generally in Map 1. Topographic maps (7.5-minute, i.e., 1:24,000 scale) showing the exact locations of the sites are on file at the NAMLRD office in Tuba City. Two of the mine sites (NA-01555 and NA0172) are comprised of two subsites, which are indicated by small case letters after the site number. All sites occur within the Chinle Formation (Fig. 1), of Late Triassic age (210-230 million years ago). Inadequate lithostratigraphic resolution of members (= subdivisions) of the Chinle Formation has impeded correlation of Late Triassic fossil localities in the Cameron area with occurrences elsewhere in northern Arizona (Kirby et al., 1991). Imprecise field recognition of the informal sandstone and mudstone member, the underlying Shinarump Member, and basal deposits of the overlying Petrified Forest Member by other workers has confused stratigraphic placement of localities in the lower part of the Chinle.

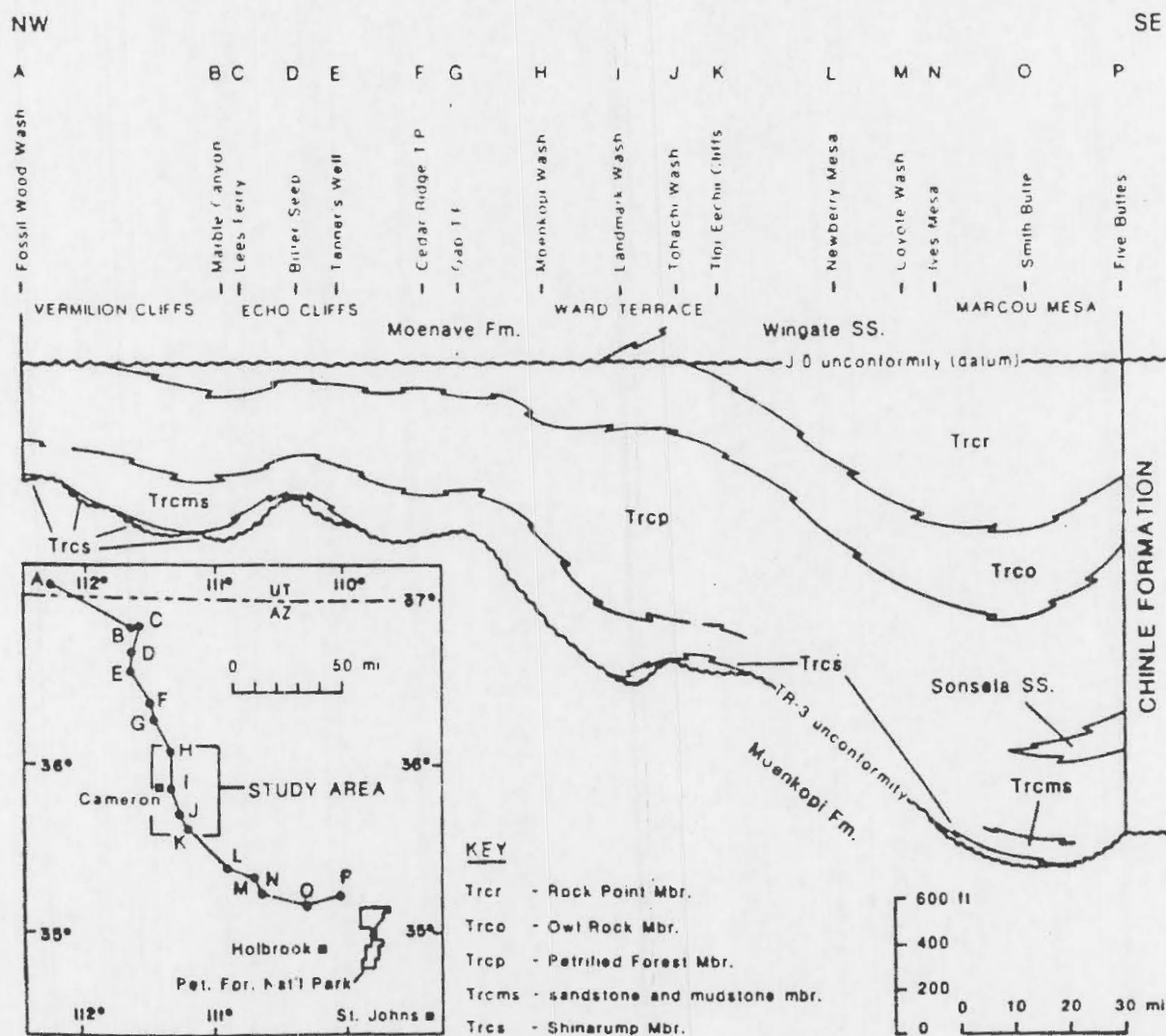


Figure 1. Generalized geologic cross section showing the distribution of Chinle Formation members between the Vermilion Cliffs and Marcou Mesa, northern Arizona. (Modified from Kirby, 1991).



Chinle strata between Black Point and the Ward Terrace dip 3 degrees northeast along the dip slope of the Kaibab Monocline (Cooley et al., 1969). West of the river, the lowest site in the section (NA-0166) occurs within mottled to banded, red to tan, medium- to coarse-grained sandstone to conglomeratic sandstone, assigned here to the upper part of the informally named sandstone and mudstone member. The second site in this area (NA-0155 a,b) occurs in a sequence of blue, gray and red mudstone with subordinate tan and gray sandstone, assigned to the basal portion of the Petrified Forest Member. The base of the mined interval (level of the ore-bearing sand) at this site occurs 15 to 20 feet above the top of the sandstone and mudstone member. The contact between the members in this area is placed at the "bleached sandstone" horizon described by Wilson (1956).

Mine sites east of the river also occur within a section of blue, gray and red mudstone and subordinate tan and gray sandstone assigned to the lower part of the Petrified Forest Member. The section is subdivided by laterally extensive scour contacts, which exhibit paleotopographic relief. On the southern side of To Nahakaad Wash, open pits of the lowest sites (NA-0179, NA-0180) access a sandstone horizon 10 to 15 feet above the top of the sandstone and mudstone member, which correlates with the mined interval at site NA-0155 a,b. This horizon is also accessed at sites NA-0172 a,b, NA-0173, NA-0174, and NA-0175. Fossiliferous zones overlapping the uppermost vertical ranges of these pits occur 40 to 50 feet above the ore-bearing horizon. Alluvial cover and inadequate vertical exposure prevented detailed assessment of the position of the site north of To Nahakaad Wash (NA-0163).

GEOLOGIC DESCRIPTION OF MINE SITES  
AND  
DISCUSSION OF PALEONTOLOGIC RESOURCES

Site NA-0155 (Charles Huskon No. 10)

This site is divided into two separate subsites, 55a and 55b.

Subsite 55a

Description: The lithology of the mined interval in the open pit at subsite 55a consists of a yellowish-tan to tan, medium- to coarse-grained, bentonitic sandstone (Fig. 2). Bentonite is an open lattice clay that readily expands with the addition of water. In outcrop, bentonitic sandstone has a frothy appearance that tends to obscure bedding relationships. Bentonite content of the sandstone averages 15%; its presence is believed to be due to the alteration of volcanic ash to clay-sized (less than 4 microns) material. Isolated gypsum crystals ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) were found in association with the ore sandstone.

All sedimentary structures of the ore sandstone were removed during the mining operation. Paleocurrent readings from the overlying light purple sandstone (overburden) measure 50, 57 and 73 degrees which indicates that streams were draining to the northeast.

The paleontologic sample (Fig. 3) from subsite 55a (= MNA Locality 1391) includes:

Field Specimen

Number

Identification

F80, F81

cf. Metoposauridae, partly reconstructed palate and associated bone fragments of a small skull, from in-situ specimen

F84, F85, F86,  
F87, F88

cf. Phytosauridae, partly reconstructed bones of nasal and cheek region with associated bone and tooth fragments, from in-situ specimen



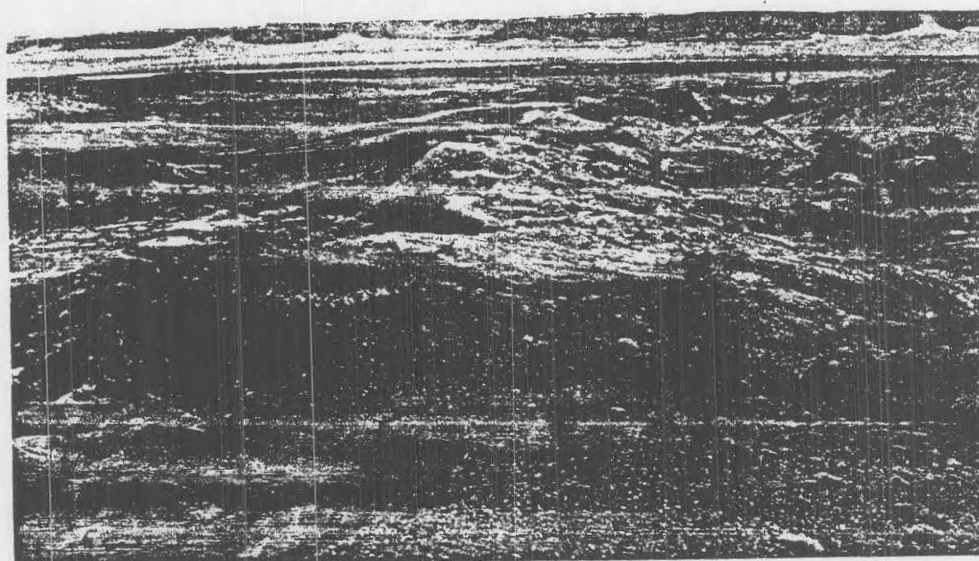


Figure 2. Overview of pit 55a (dashed area) and yellowish-tan to tan colored waste piles. In-situ vertebrate bone sites occur in reddish-brown, bentonitic overburden at western end of site (a), and in tanniah, bentonitic overburden in lower horizon at eastern end (b).



Figure 3. Reconstructed specimens from in-situ fossil occurrences at subsite 55a: (a) partial palatal elements from the skull of a small metoposaurid amphibian, (b) bones of the nasal and cheek region from the skull of a phytosaurian reptile, and (c), part of the pelvis of a lightly built thecodont carnivore or small dinosaur.

F90, F91	cf. Phytosauridae, bone and tooth fragments from eroded rostrum or mandible?
F93	cf. Thecodontia or Saurischia?, partly reconstructed ilium and associated bone fragments, from in-situ specimen
F94	Tetrapoda, bone fragment
F82, F95	Tetrapoda, coprolites
F96, F97	cf. Invertebrata, insect burrows? from in-situ outcrops
F99, F100	Plantae, stalk?, stem?, and twig? impressions from in-situ outcrops
F83, F89, F92, F98	Plantae, rhizolith fragments

Discussion: The paleontologic samples collected from subsite 55a occur as float, from in-situ specimens in undisturbed outcrops, and from litter on the surface of waste piles. Two in-situ vertebrate specimens occur at the eastern end of the pit, in a fossiliferous horizon 5 to 7 feet above the ore-bearing sandstone. A third in-situ specimen was found in a second horizon 20 to 25 feet above the first, at the western end of the pit. Subsurface bone concentrations at these sites were left in place for subsequent salvage. Bone and coprolite fragments from the lower horizon were collected as float from undisturbed outcrops during lateral traverses to the south. A number of large fossil log sections weathering from the upper horizon were noted on the southwestern perimeter. Waste rock was bulldozed onto outcrop equivalents of these horizons at several points along the pit perimeter. Plant impressions and possible insect burrows were collected from lithified Late Triassic sandstones and overlying Quaternary wind-blown sediment exposed along the southern pit wall. Waste piles on the northern flank produced fragments of bone, teeth, and rhizoliths (silicified natural cast off plant rootlets), as well as large log sections. No specimens were collected from the floor of the pit.

### Subsite 55b

Description: The pit at subsite 55b (Fig. 4) is located a few hundred feet east of the pit at subsite 55a and occurs at the same relative stratigraphic level. The mined interval is contiguous between the two pits. The uraniferous interval is a yellowish-tan to tan, medium- to coarse-grained, bentonitic sandstone. Bentonite (interstitial swelling clay) content within the sandstone ranges from 15-25%.

Coarse-grained, crossbedded sandstone at the pit level contains northeast to southeast paleocurrent readings (40, 50, 73, 103, 145 degrees). This is in agreement with pit at subsite 55a, the upstream component to this fluvial system. Nested (up to 5 scours) mudstone-filled scours within the overlying bentonitic overburden document active gullying of the Petrified Forest Member landscape.

Discussion: Fossil occurrences at subsite 55b (= MNA Locality 1392) were restricted to a number of moderately-sized petrified log fragments comparable in preservation and color to those at 55a (Fig. 5). Fragments occurred as dismembered segments and splinters, in association with waste and weathered from in-situ remnants of the uraniferous sandstone ledge.

### Site NA-0163 (Ryan No. 1)

Description: The lithology of the open pit at site 63 consists of a light tan, fine- to medium-grained, bentonitic sandstone (Fig. 6). Interstitial bentonitic clay ranges from 20-30%. All sedimentary structures and paleocurrent data were destroyed during the mining operation.

Discussion: No fossil occurrences were noted in the waste piles at site 63. Flooding by water and alluvial sediment accumulation prevented direct examination of the floor and walls of the pit. With the exception of small slump scars, surrounding outcrops are covered by drapes of Quaternary terrace

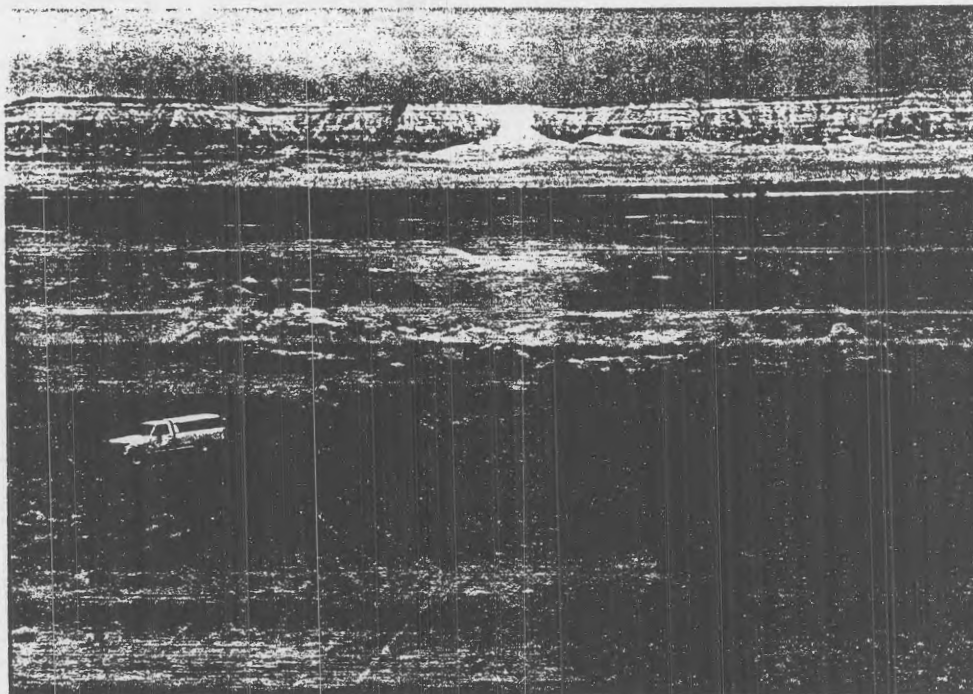


Figure 4. Overview of subsite 55b with surrounding low-grade uranium waste piles. Multicolored cliff in background is Ward Terrace.

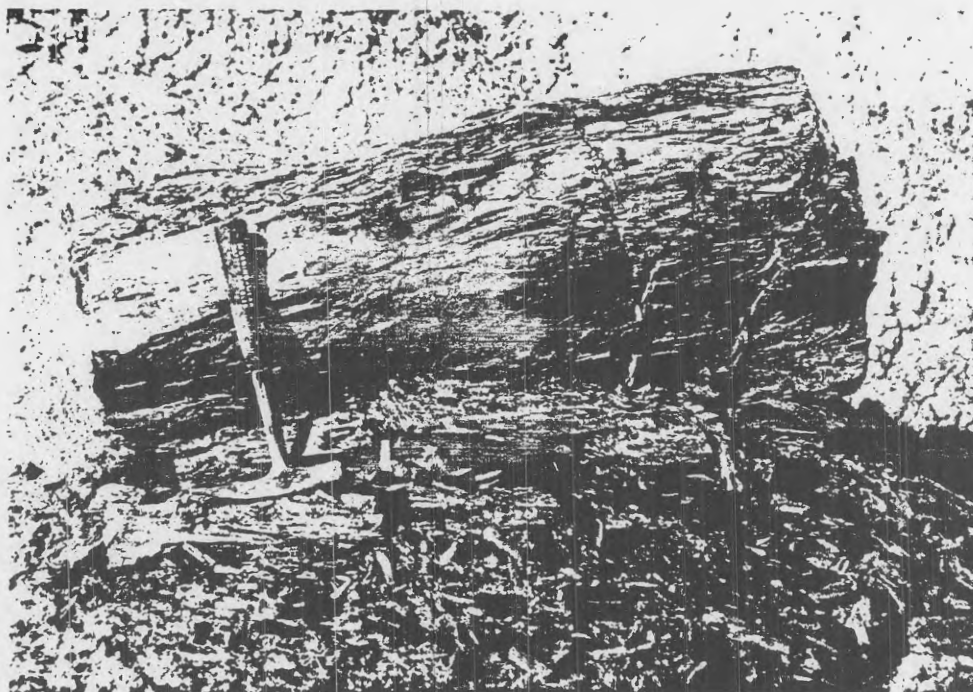


Figure 5. Subsite 55b: Orange colored petrified wood shows in-situ disaggregation of black charcoal-like wood fragments. The orange colored siliceous versus the softer, black charcoal-like wood is merely a function of preservation. Fieldwork has shown that the black charcoal-like preservation is usually restricted to thin layers on the exterior of the wood while the thick cores favor preservation by siliceous solutions.



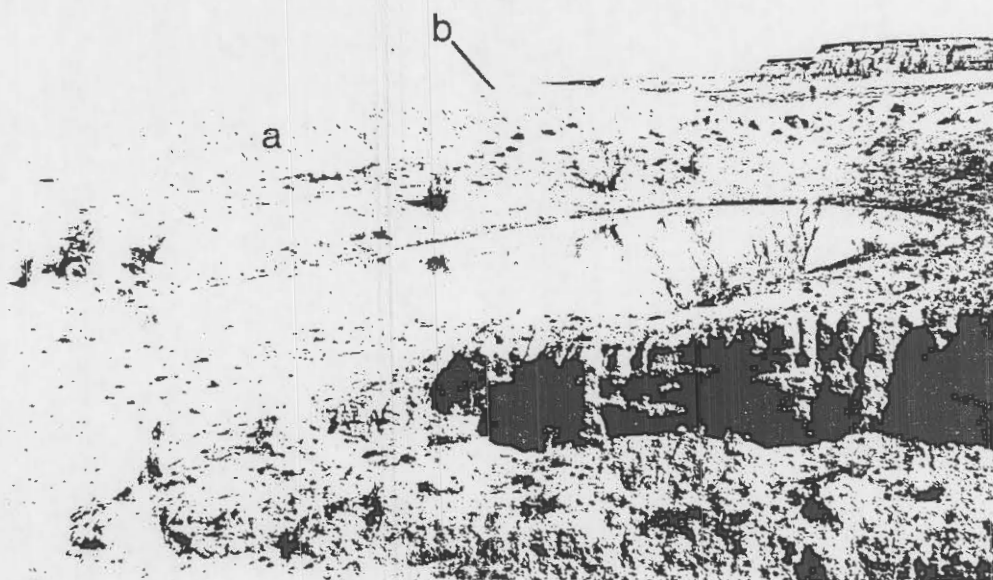


Figure 6. Overview of water-filled open pit at site 63 (person for scale). Overburden waste pile (a) is a light purplish-tan, bentonitic sandstone. Mined interval is visible on top layer of waste pile as a light-tan, bentonitic sandstone (b).

gravel. Lateral traverses confirmed the position of two older MNA fossil localities (174 and 206) several thousand feet to the north and east, which contain fossil logs and coprolites. A specimen of the gastropod cf. Valvata? sp. (field specimen number F104) was recovered as float at MNA 206 during the reconnaissance. Topographic relations indicate that the uppermost vertical range of the pit at site 63 may overlap with the base of the fossiliferous horizon exposed at the older MNA localities.

**Site NA-0166 (Yazzie No. 105)**

Description: The color of the mined interval at site 166 ranges from tan to yellowish-brown to gray (Fig. 7). The more gray the color of the sample, the greater the organic/carbonaceous material content. The more yellowish-brown the sandstone, the greater the limonite cement content (yellowish-colored iron-oxide). The ore interval is a medium-grained, carbonaceous (5-10%) sandstone. Interstitial bentonitic content is less than 10%. Some of the sandstone was found to contain irregularly-shaped, red (oxidized) volcanic glass shards. Displaying a conchoidal fracture pattern when crushed, the glass shards represent airborne volcanic glass that was transported through the air via volcanic eruption. The interstitial bentonite (volcanic clay), found as framework matrix in most of the pit sandstones to date, represents volcanic ash/glass shards that have diagenetically altered to clay-sized (<4 microns) material.

Paleocurrent readings taken from straight- and sinuous-crested cross-bedding at the stratigraphic level of the pit document stream flow as northeasterly (9, 10, 15, 48, 49, 52, and 62 degrees). Site 166 is interpreted as being within the informal sandstone and mudstone member of the Chinle Formation, which is directly overlain by the Petrified Forest Member.

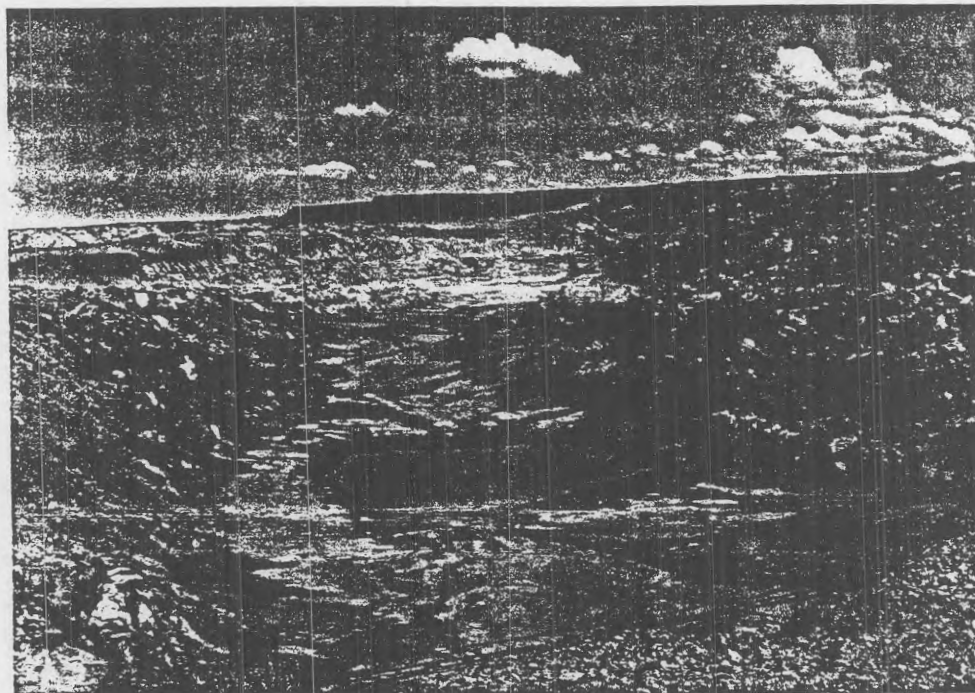


Figure 7. Arcuate geometry (meander bend?) of mined uranium pit at site 66. Note yellowish-brown color of sandstone along pit wall and of adjacent overburden material.

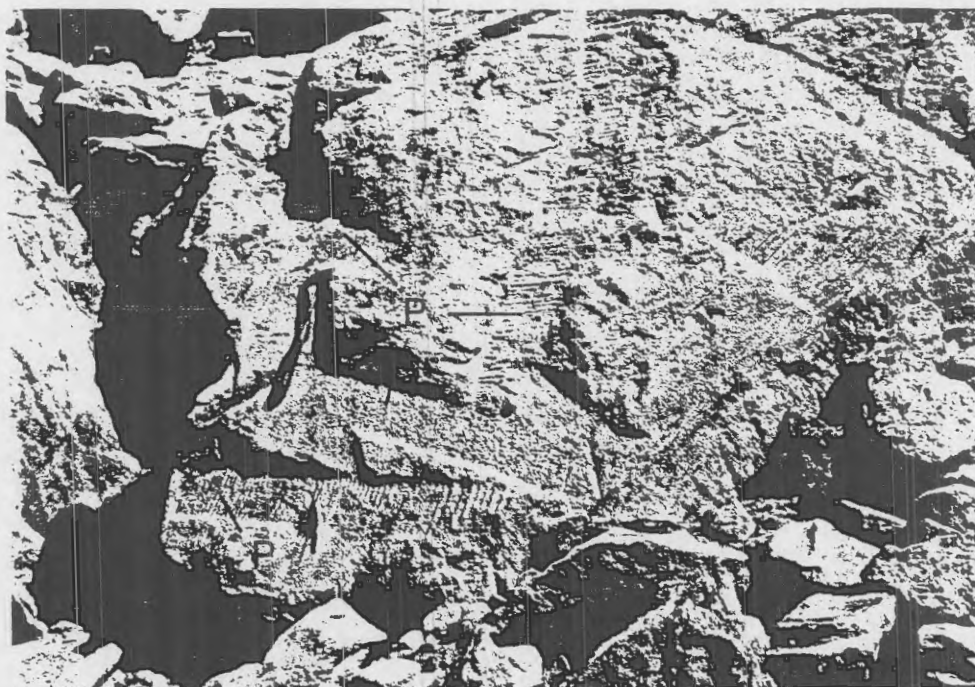


Figure 8. Site 66: Crosscutting ridged impressions of strap-like leaves? (P) on underside of sandstone block. Maximum width of largest foliage? sample is 7 inches (hammer for scale).



Discussion: Fossil occurrences at site 66 (= MNA Locality 1393) are dominated by large sandstone blocks in the waste piles on the northwestern and southeastern perimeter of the pit. The blocks bear large impressions of leaf?, woody stem?, and bark? fragments, and by moderately-sized fragments of petrified logs in the piles and pit. The largest of the impressions (Fig. 8) is an elongate, strap-like leaf? structure, 78 inches in length and 7 inches wide, with a ridged or segment-like texture. Dr. Sidney R. Ash, paleobotanist at Weber State University in Ogden, Utah, considered similar specimens at site NA-0125 (Kirby et al., 1991: Fig. 16) comparable to foliage of the cordaitan plant Pelourdea (oral comm., 1991).

A single in-situ log, exposed at the base of the pit wall at the southern site boundary, measured 20 inches in diameter and was oriented at 49 degrees (northeast). The specimen was inadequately exposed for length measurements.

### RAMCO Complex

Overview: Sites NA-0172 a,b, NA-0173, NA-0174, and NA-0175 (Fig. 9a) are a complex of large open pit mines excavated by the Rare Metals Corporation of America (RAMCO). The vertical ranges of the sites overlap a stratigraphically thick and areally extensive zone of fossiliferous mudstone and subordinate sandstone (Fig. 9b), exposed topographically at two levels.

Outcrop slopes in the northern, western, and southern sectors of the complex are overlain by extensive drapes of Quaternary terrace gravel measuring 0.5 to 3 feet thick. Concentrations of bone, coprolites, and fragmentary fossil logs in the lower RAMCO horizon (= MNA Localities 1394, 1995, 1396, 1397) were documented in-situ in a series of slump scars and as float debris in an area overlapping sites 72 a,b, 73, and 75, and in low-relief badlands on the southeastern perimeter of the complex (= MNA Locality 1399). In-situ occurrences of bone, coprolites, and larger fossil stumps? and logs in the

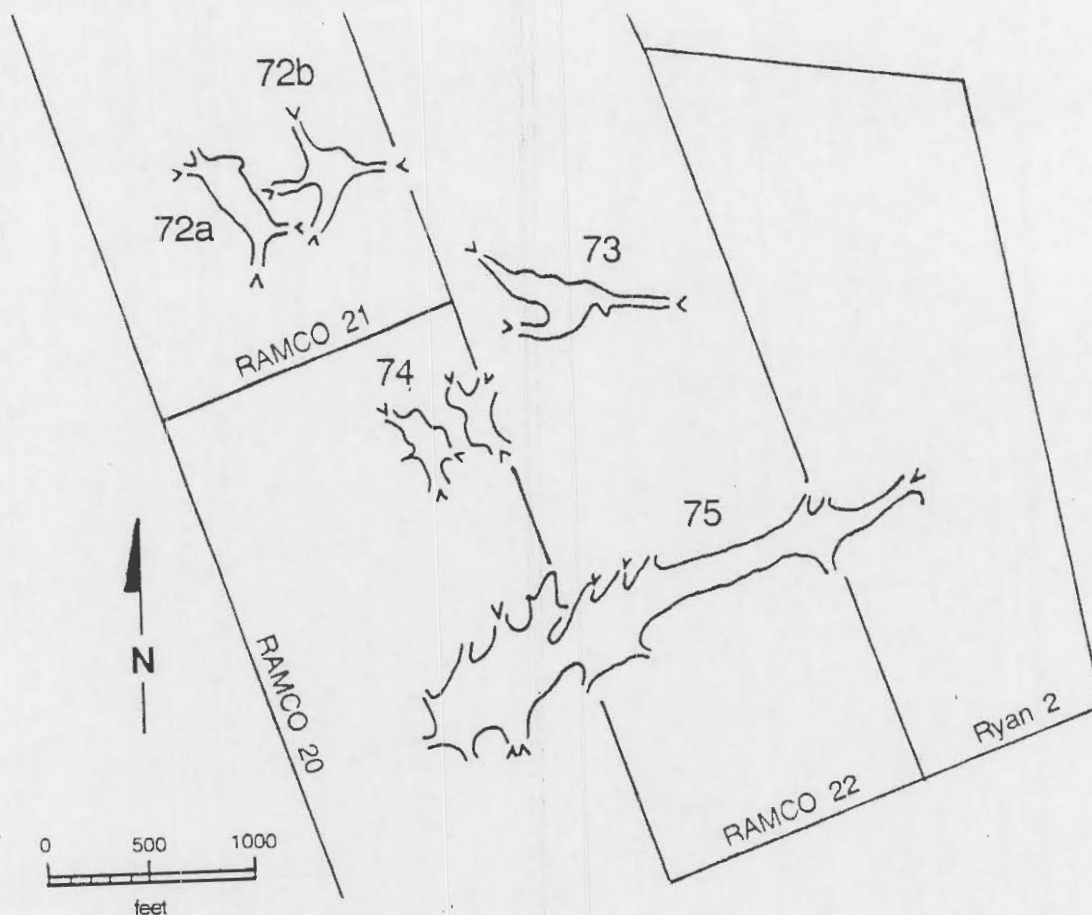


Figure 9a: Plan view of RAMCO open pit mine complex (Sites 72, 73, 74, and 75).

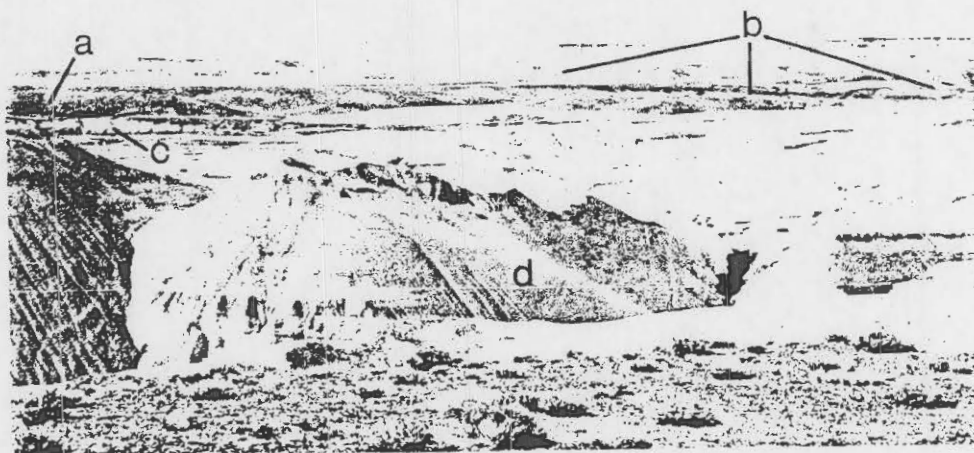


Figure 9b. Overview of eastern portion of RAMCO open pit mine complex, showing relations of lower (a) and upper (b) exposures of prolific fossiliferous zone to uppermost vertical intervals of pits at sites 73 (c) and 75 (d).

upper RAMCO horizon (= MNA Locality 1398) were documented in higher-relief badland exposures on the northeastern perimeter of the complex. Topographic relations observed during lateral traverses indicate that the level of MNA Localities 174 and 209 (near site 63) is probably equivalent to at least the lower horizon at the RAMCO complex. In both areas, numerous in-situ fossil sites occur as pockets in superposed scour-fill sequences, overlying surfaces of paleotopographic relief. It is emphasized that the "lower" and "upper" horizons at the RAMCO complex represent topographically-controlled exposure of a geographically widespread fossiliferous zone 20 to 40 feet thick.

Sites in the area of the RAMCO complex produced diverse and abundant vertebrate fossil specimens. Material collected during the present survey includes whole and partial elements ranging from large and robust to small and delicate. Specimens are referable to metoposaurid amphibians, phytosaurian, aetosaurian, and rauisuchian thecodont reptiles, and a probable dinosaur.

**Site NA-0172a (RAMCO No. 21)**

Description: The uraniumiferous interval in the open pit at subsite 72a is a light-tan, fine- to medium-grained, bentonitic sandstone (Fig. 10). Interstitial bentonite content (swelling volcanic clay) averages 20%. All sedimentary structures of the ore sandstone were removed during the stripping operation. The frothy character of the overburden in the pit wall obscures the majority of bedding relationships/associations.

The paleontological sample from subsite 72a (= MNA Locality 1394) includes:

**Field Specimen**

Number

Identification

F105

Tetrapoda, bone fragment

F106

Plantae, fossil log fragments



Figure 10. Eastern side of pit 72a (person for scale). Low-grade uranium ore piles are a light-tan color (a). Overburden visible in pit wall is a frothy, reddish-brown to bluish-purple, bentonitic mudstone/siltstone/sandstone sequence.

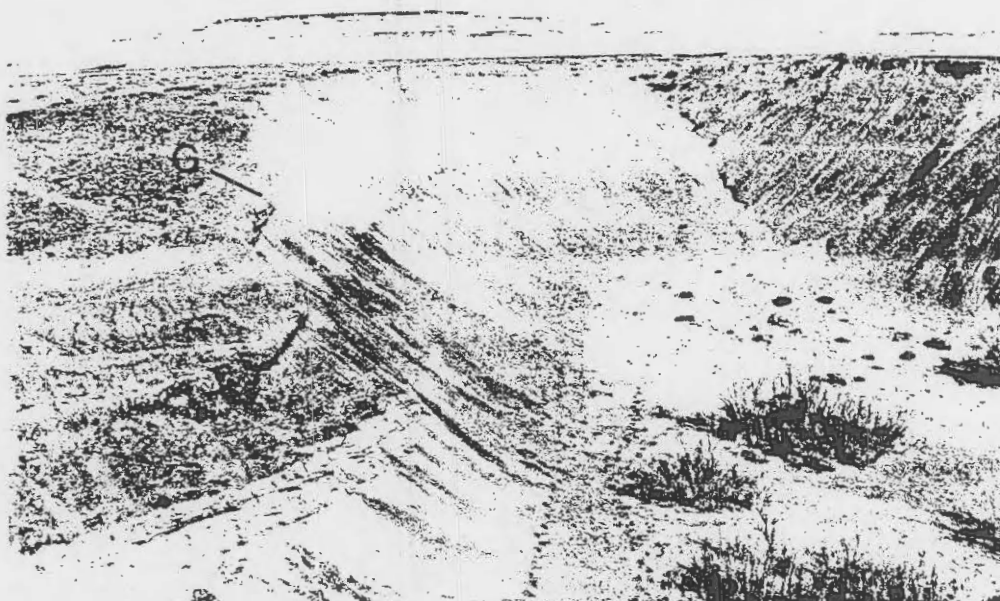


Figure 11. Overview of open pit 72b, located east of pit 72a. Note similar reddish-brown to bluish-purple colors of overburden in pit wall. Gravelly alluvium cap averages 2 feet thick (G). Ward Terrace visible in background.

Discussion: The wood sample from subsite 72a was collected from an in-situ cluster of fragments, weathering from a slump scar in gravel-covered slopes along the southwestern pit perimeter (lower RAMCO horizon). The fragments bear a roughened calcareous texture in some areas, superficially similar to the texture of wood rotted by fungus prior to burial. It is uncertain whether the texture might also have originated as solutional deposition during ore genesis. In-situ wood fragment clusters were also noted in exposures between lobes of gravel on slopes at the southeastern end of the pit. A bone fragment was collected as float near the base of a waste pile at the northwestern end of the pit. No specimens were noted along the walls or floor of the pit.

**Site NA-0172b (RAMCO No. 21)**

Description: The lithology of the mined interval at subsite 72b is a light-tan, fine- to medium-grained, bentonitic sandstone, similar to the lithology at subsite 72a. Bentonite content ranges from 20-30 percent. The only remaining sedimentary structures occur in the pit wall (overburden) as horizontal to slightly inclined, finely-laminated mudstone, siltstone and sandstone layers (Fig. 11).

The paleontologic sample collected from site 72b (= MNA Locality 1395) includes:

**Field Specimen**

Number:

Identification:

F106

cf. Aetosauria, scute fragment

Discussion: The scute fragment was collected as float in the easternmost adit of the pit at subsite 72a. Ridged sculpturing of the preserved articulation surface is similar to that of dorsal armor described for the aetosaurian reptile Desmatosuchus (Long and Ballew, 1985). The exact



provenance of the specimen is difficult to determine, but an overturned fossil stump occurs in a slump scar in a gravel covered slope on the northern perimeter of the site. The scar exposes mudstone of the lower RAMCO horizon, and occurs at a stratigraphic level equivalent to that of the upper pit walls.

### Site NA-0173

(RAMCO No. 22)

Description: The lithology of the mined interval at site 73 is a light-tan, fine- to medium-grained, bentonitic sandstone. Interstitial bentonite (expanding clay matrix) content ranges from 20-30%. The pit at site 73 has been in-filled with alluvium, so no sedimentary structures of the ore-bearing interval could be measured (Fig. 12).

The diverse and abundant paleontological sample (Fig. 13) collected at site 73 (= MNA Locality 1396) includes:

#### Field Specimen

<u>Number</u>	<u>Identification</u>
F108, F122, F136, F139	cf. Metoposauridae, fragmentary pectoral girdle elements
F109	cf. Metoposauridae, tooth socket
F110	cf. Metoposauridae?, cast of tooth socket?
F121	cf. Metoposauridae, partial skull roof element
F111, F112, F125	cf. Phytosauridae, teeth
F122, F123	cf. Phytosauridae, partial rostra
F126, F127	cf. Phytosauridae, scutes
F128	cf. Phytosauridae?, quadrate or astragalar/calcaneal? fragment
F113, F114, F129, F140	cf. Aetosauria, partial scutes
F141	cf. Sphenosuchia?, tooth
F117, F130	Reptilia, partial vertebral centra
F118, F137	Reptilia, scute fragments
F131	Reptilia?, fragments of small skull?
F119, F132, F133	Reptilia?, rib or neural arch? fragments
F115, F116, F134, F138, F142, F144	Tetrapoda, bone fragments
F135, F143	Tetrapoda, coprolites
F145	Rhizolith fragments



Figure 12. Eastern side of pit at site 73 shows in-filled vegetated pit and reddish-brown to bluish-purple overburden visible in pit walls. Light-tan, low-grade ore sand stripped from pit is visible at (a).

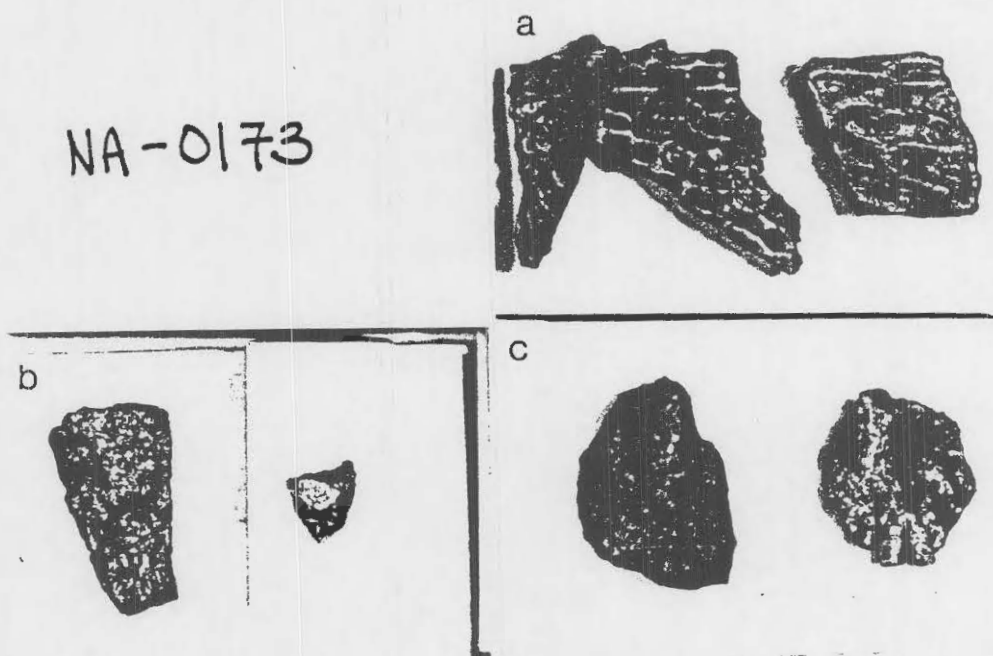


Figure 13. Representative paleontological sample from site 73: (a) fragments of the pectoral complex of a metoposaurid amphibian, (b) teeth of a phytosaurian reptile, (c) partial scutes of an aetosaur.



Discussion: The most abundant concentrations of bone at site 73 occurs in-situ in slump scars on gravel-draped outcrop slopes (lower RAMCO horizon), immediately abutting the northeastern pit rim and northernmost edit. A number of smaller in-situ concentrations occurred within an amphitheater formed by stratigraphically equivalent outcrop slopes, flanking small drainages along the northwestern perimeter of the site. In places throughout the interval, the gravel veneer was thin enough to permit bone to weather through to the surface without benefit of slope failure. A single bone fragment was collected as float on the flats immediately adjacent to the southern pit rim. A number of the partial scute specimens are comparable to those of the aetosaur Stagonolepis (= Calypotosuchus), considered age diagnostic of Late Carnian strata (lower Petrified Forest Member) in northern Arizona (Long and Ballew, 1985; Hunt and Lucas, 1990).

#### Site NA-0174 (RAMCO No. 20)

Description: The ore interval at site 74 is a light-tan, fine- to medium-grained, bentonitic sandstone (Fig. 14). Bentonite (volcanic clay matrix) content ranges from 20-30%. There is no overburden at this locality. Gravelly alluvium can be seen directly draping the light-tan ore sandstone suggesting that during the stripping operation, the target sandstone may have been visible at the surface.

Discussion: Flooding of the pits at site 74 by water prevented direct examination of the walls and floors. No fossils were noted on the waste pile surfaces or on the surrounding alluvial flats. The topographic level of the pit rim places it below observable basal exposures of the lower RAMCO horizon.

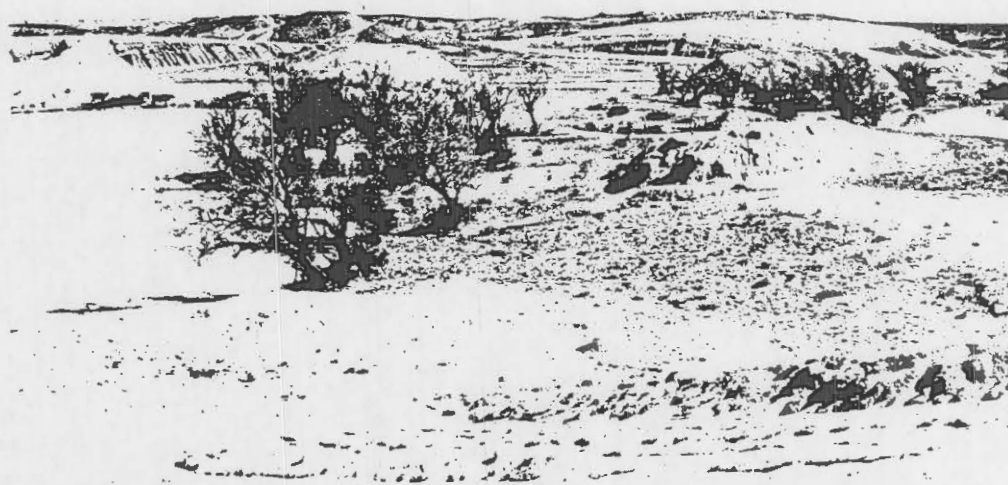


Figure 14. Two water-filled pits at site 74 (cows for scale). No overburden at this locality. Light-tan sandstone (ore horizon) is directly overlain by gravelly alluvium.

Site NA-0175 (Ryan No. 2)

Description: The ore interval at site 75 consists of a tan, fine- to medium-grained, bentonitic sandstone. Bentonitic overburden in the pit walls is a bluish-gray to reddish-brown color (Fig. 15). Interstitial bentonitic clay matrix ranges from 20-30%. A large channelform (225 foot width, 35 foot depth) documented near the top of the pit wall indicates a northwest paleoflow (323, 335 degrees) for the channel system. In-fill of the channel scour consists of low-angle, heterolithic sandstone/mudstone layers at approximately 90 degrees to the channel axis. This suggests lateral accretion or meandering/sinuosity of the channel system. Dozens of petrified logs oriented southwest to northwest (225, 315, 323, 346, 350 degrees) within the channel indicate log alignment parallel to paleoflow.

The paleontological sample (Fig. 16) from site 75 (= MNA Locality 1397) includes:

<u>Field Specimen Number</u>	<u>Identification</u>
F148	cf. Metoposauridae, fragmentary pectoral girdle element
F167	cf. Phytosauridae, tooth
F165	Reptilia, acute fragment
F146	Reptilia?, articular surface?
F147, F160, F164	Tetrapoda, bone fragments
F149, F150, F151, F152, F156, F157, F158, F161, F166	Tetrapoda, coprolites
F159	Tetrapoda, pyritized coprolites
F153	Tetrapoda?, coprolite?
F162	Bivalvia, cast of articulated unionid valves
F163	Plantae, carbonized wood
F154	Plantae, rhizolith fragments

Discussion: The paleontological sample from site 75 is dominated by an abundant, diverse, and a well-preserved suite of coprolites (fecal material) collected from large waste piles situated along the north-central perimeter of the site. Several of the more massive specimens exhibit a range

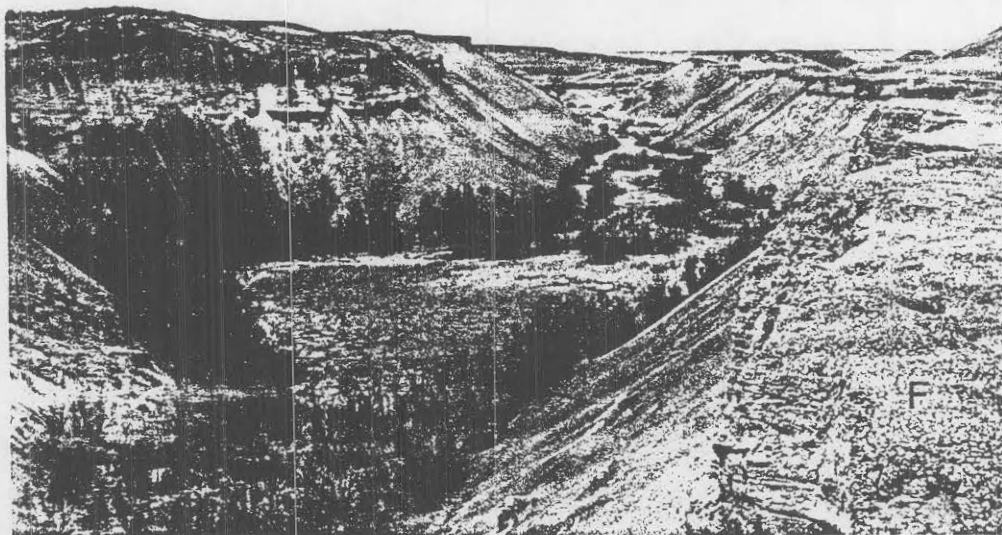


Figure 15. Looking southwestward from pit at site 75. Slopes of pit represent bentonitic overburden. Note frothy appearance of swelling bentonitic sandstone at ground surface (F).

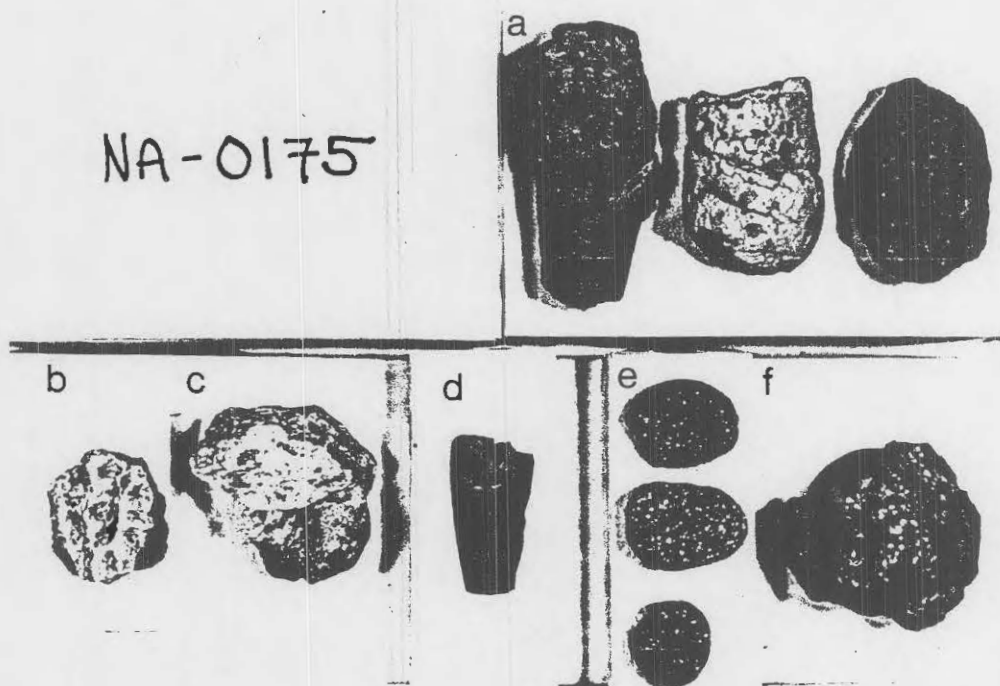


Figure 16. Representative paleontological sample from site 75: (a) massive, well-preserved coprolites (fecal material), (b) metoposaurid girdle fragment, (c) fragmentary reptilian? articular surface?, (d) phytosaur tooth, (e) pyritized coprolites, (f) cast of articulated unionid bivalve.

of inclusions, such as possible comminuted plant material and the valves of conchostrachans (fresh water clam shrimp). An articulated bivalve cast contains material similar to the primary mass of a number of the coprolites, suggesting origins as an inclusion, but may alternatively have been modified by a solutional episode. Fragmentary bone specimens were collected as float, from in-situ outcrops at the base of waste piles on the northcentral and eastern perimeters of the pit rim, and from small scars cut into terrace gravels on the southern pit rim during bulldozing of waste and for drainage modification. A majority of the in-situ outcrop potentially available for examination at the site (northern pit rim) is covered by massive waste piles; the remainder of undisturbed bedrock (southern pit rim) occurs beneath alluvial terrace gravel. Exposed in-situ outcrop, logs along the pit walls, slump scars, and topographic relations of the site indicate that the upper portion of the interval exposed in the pit represents at least the lower RAMCO horizon, and perhaps a portion of the upper horizon.

#### Site NA-0179 (Yazzie No. 1)

Description: The base of the ore horizon at site 79 measures 13 feet above the top of the informal sandstone and mudstone member of the Chinle Formation (Fig. 17). The ore interval is a light-tan, fine- to medium-grained, bentonitic sandstone. All sedimentary structures and paleocurrents from the ore sandstone were removed during the mining operation.

Discussion: The paleontologic sample from site 79 (= MNA Locality 1340) is restricted to fragments of rhizoliths (field specimen number F168) collected as float from waste piles. No other fossil occurrences were noted in the walls or on the floor of the pit. Surrounding undisturbed outcrops corresponding to the pit interval are obscured by alluvial cover.



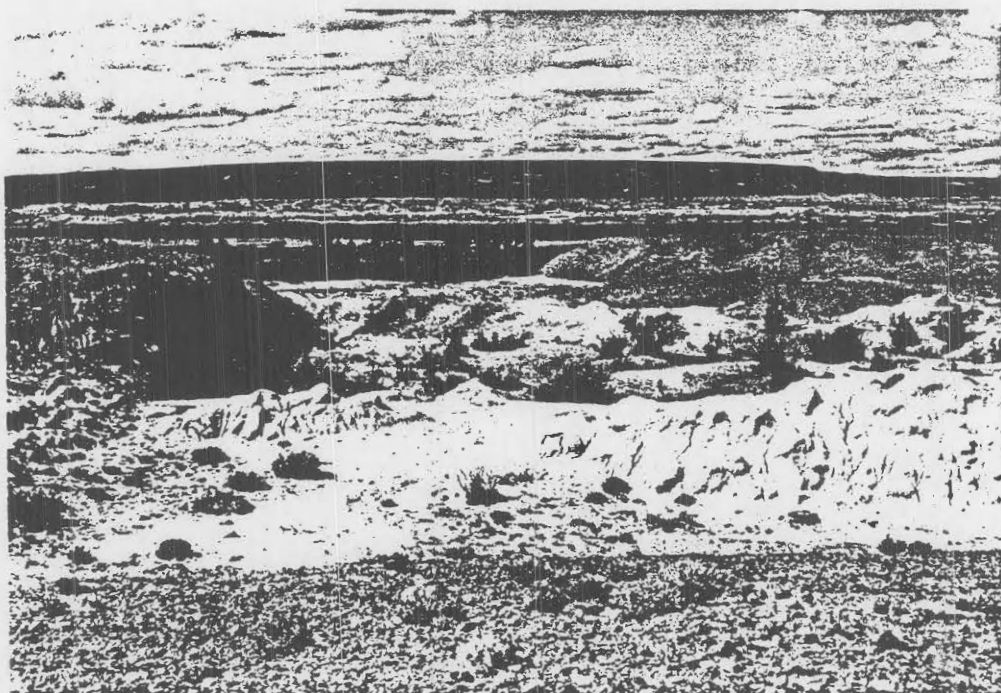


Figure 17. Light-tan ore sand waste piles at site 79. Informal sandstone and mudstone member of the Chinle Formation is visible in background as sandstone outcrop lying directly above and behind the Little Colorado River.

Site NA-0180 (Charles Huskon No. 18)

Description: The lithology of the ore horizon at site 80 consists of a light-tan, fine- to medium-grained, bentonitic sandstone. Overburden is a finely-laminated, conglomeratic bentonitic sequence consisting of mudstone, siltstone and sandstone (Fig. 18). Paleocurrents measured in the pit wall (overburden) indicate a northeast paleoflow direction (20, 25, 44 degrees). Other sedimentary structures include an asymmetric channel scour with a large clast of bank cavitation (2.5 foot width) resting on the cutbank (high angle) side of the channel.

The paleontologic sample (Fig. 19) from site 80 (= MNA Locality 1341) includes:

<u>Field Specimen</u> <u>Number:</u>	<u>Identification:</u>
F169, F177	cf. Phytosauridae, teeth
F172	cf. Phytosauridae, scute
F178	Reptilia?, skull? element
F173, F179	Tetrapoda, bone fragments
F170, F174, F176	Tetrapoda, coprolites
F180	
F171, F175, F181	Plantae, rhizolith fragments

Discussion: The bulk of the paleontological sample from site 80 was collected as float from the surface of waste piles at the western and eastern perimeters of the site. A single fragmentary coprolite was collected as float from exposed in-situ outcrop at the southwestern corner of the pit rim. No other fossil occurrences were noted in the walls or on the floor of the pit. Surrounding undisturbed outcrop is obscured by alluvial cover, but the topographic position of the site suggests overlap of the uppermost vertical interval in the pit with the base of the lower RAMCO horizon. Two small (approximately 1 foot of throw) faults were noted in the in-situ outcrops along the southwestern pit rim, although it is unclear whether these originated in response to tectonism or to erosional unloading of the strata.



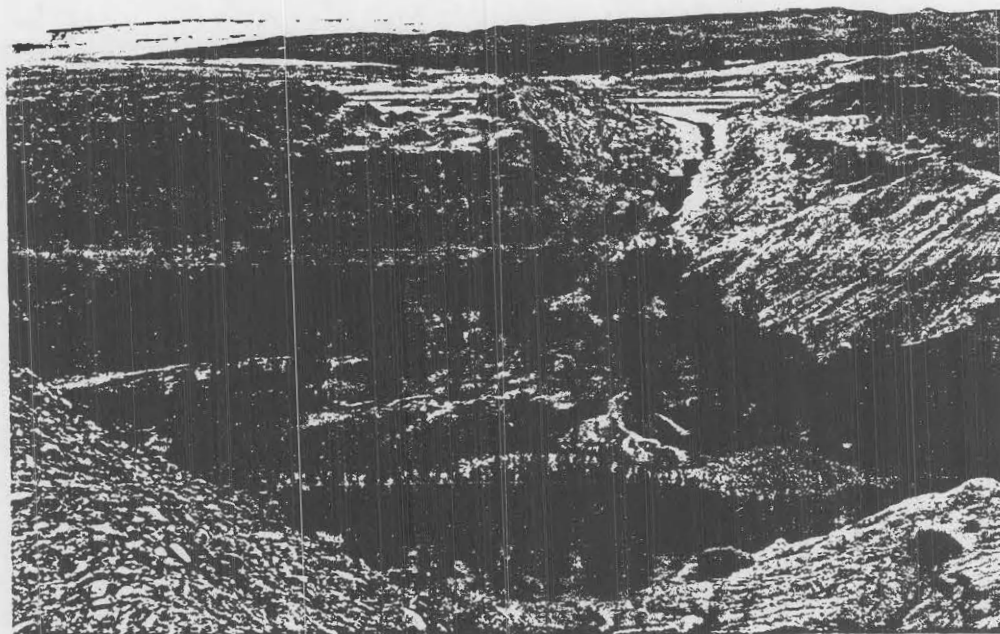


Figure 18. Looking eastward from vegetated pit at site 80. Note dissected haulage road leading to light purplish-tan waste piles. Ward Terrace at upper left in background.

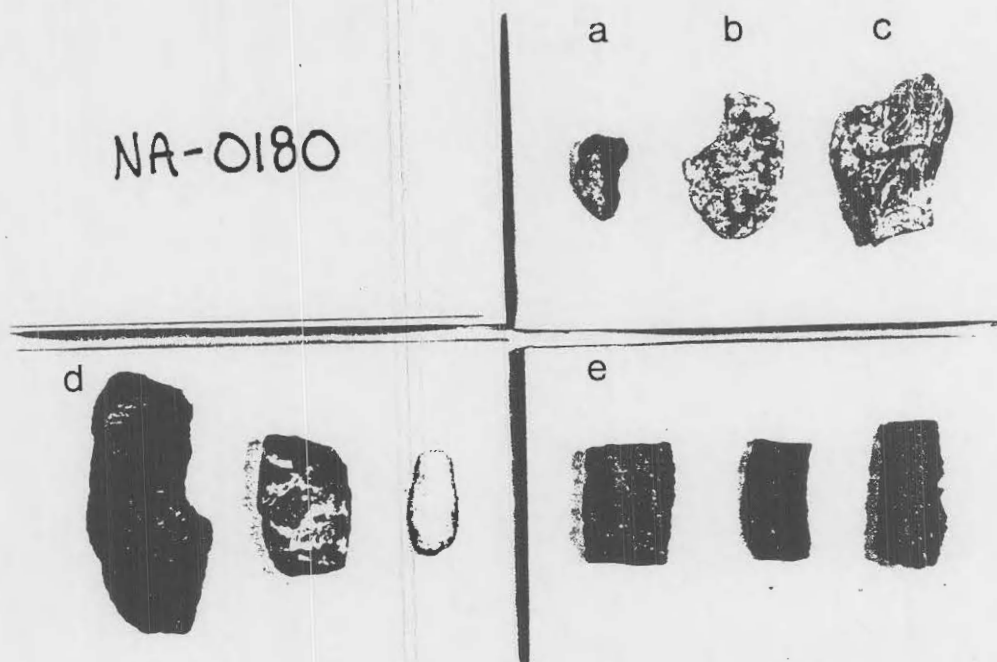


Figure 19. Representative paleontological sample from site 80: (a) phytosaur tooth, (b) phytosaur ventral acute, (c) reptilian? skull element?, (d) coprolites, (e) rhizolith fragments.

## RECOMMENDATIONS FOR PROTECTION OF PALEONTOLOGIC RESOURCES DURING MINE RECLAMATION

### Mitigation Criteria

Several criteria were used to determine potential impact on paleontologically significant localities, and to formulate recommendations for mitigation (Kirby et al., 1991). These include: 1) salvage prior to initiation of reclamation operations, 2) on-site monitoring during the course of reclamation activities, and 3) exclusion of sensitive sites or outcrops from the area impacted by reclamation operations. Recommendations for sites reviewed during the present survey are summarized below and in Table 1 at the end of this report.

Salvage is recommended if in-situ fossil specimens are of obvious scientific interest and if reclamation operations would result in the loss of important scientific information. In some cases, salvage can be conducted concurrent with reclamation operations, in conjunction with on-site monitoring. The fossil locality itself must also be appropriate for reasonable cost-effective salvage. If cost-effective salvage is not possible, it may be appropriate to recommend against salvage.

Monitoring is recommended if there is a reasonable basis to anticipate that significant material may be encountered during reclamation. This would generally have to be supported by information gathered during the field survey. Reclamation is anticipated to involve transfer of overburden and waste piles into the abandoned open pit mines,

utilizing heavy equipment such as bulldozers and/or backhoes. It may be appropriate to observe reclamation operations for fossil remains if waste piles or outcrops adjacent to a pit site have produced significant or abundant fossils.

Exclusion of a locality or outcrop from the proposed area of reclamation activities would be appropriate if a significant fossil locality or outcrops with a history of productivity occur within the impacted area, and should be left undisturbed for long term scientific study and evaluation. Such a determination is based on observation in the field during the survey, and research of available literature on the history of the localities and/or outcrops in question.

#### Mitigation Recommendations

Site NA-0155 a,b Three in-situ subsurface fossil localities were found at subsite 55a but were left in place for future mitigation.

Reconstruction of surface fossil material from these localities has already allowed preliminary identification of some of the elements and taxa represented. The positions of the localities close to existing access points for heavy equipment, the occurrence of identifiable fossil specimens in waste piles and in-situ outcrops elsewhere in the subsite, and the emplacement of waste and overburden piles atop potentially fossiliferous strata, indicate a high risk of impact to paleontological resources during reclamation. Salvage of the in-situ specimens is recommended to safeguard them. Monitoring of the reclamation

of waste and overburden and potential impact to underlying outcrops, as well as exclusion of undisturbed outcrops where feasible, are also recommended.

Fossil occurrences at subsite 55b are restricted to dismembered fossil log fragments of doubtful taxonomic or paleoecologic value. Mitigation is not recommended for this subsite.

**Site NA-Q163** No fossil occurrences were noted at site 63, and adjacent older localities occur at a distance placing them at minimal risk of impact during reclamation activities. However, the outcrops surrounding site 63 may produce fossils similar to those collected at the older localities, and exclusion of these strata from reclamation impacts is recommended where feasible.

**Site NA-Q166** Site 66 contains several specimens of a plant megafossil (leaf impressions) considered to be comparatively rare in the fossil record (Sidney R. Ash; oral comm., 1991). Salvage of some of these specimens is recommended by the cost-effective peel moulding technique and/or by removal from the site.

**Site NA-Q172 a,b** Subsites 72 a and b have produced limited numbers of fragmentary fossil specimens. However, the stratigraphic position of the two subsites relative to a prolific fossiliferous zone, and fossil specimens collected from closely abutting undisturbed outcrops on the southeastern margin of the subsites, indicate a high risk of impact to paleontological

resources. Monitoring of reclamation activities where in-situ outcrops will be disturbed, and exclusion of undisturbed outcrops from impact where feasible, are recommended for both subsites.

**Site NA-0173** In-situ outcrops closely abutting the northern margins of the pit and waste piles at site 73 produced abundant and diverse vertebrate fossils, including age-diagnostic specimens. Monitoring of reclamation activities at this site is recommended in those areas where heavy equipment may contact in-situ fossiliferous outcrops. Exclusion of these outcrops is recommended where feasible.

**Site NA-0174** No fossil occurrences were noted on the waste piles or along the pit margins at site 74. Stratigraphic relations indicate that the site does not overlap the prolific fossiliferous zone exposed in the area of the RAMCO complex. Mitigation is not recommended for site 74.

**Site NA-0175** A diverse and abundant coprolite sample was collected from three large waste piles at site 75. Fossil specimens collected from in-situ outcrops along the pit margin, and stratigraphic overlap of the site with the prolific fossiliferous zone in the area of the RAMCO complex, indicate a high risk of impact to existing paleontologic resources. Monitoring is recommended during reclamation of the waste and overburden accumulations, and during related impact to underlying fossiliferous outcrops.



Site NA-0179 A limited sample of fragmentary rhizoliths of doubtful provenance was collected from waste piles at site 79. No other fossil occurrences were noted at the site during the survey. Mitigation procedures are not recommended for site 79.

Site NA-0180 A restricted sample of fragmentary fossil specimens was collected from waste piles and in-situ outcrop at site 80. However, a limited stratigraphic overlap of the site interval with the prolific fossiliferous zone at the RAMCO complex is possible, and a potential for impact to paleontological resources exists. Exclusion of undisturbed outcrops from reclamation activities is recommended where feasible.

TABLE 1: SUMMARY OF RECOMMENDED MITIGATION

<u>SITE</u>	<u>SALVAGE</u>	<u>MONITORING</u>	<u>EXCLUSION</u>	<u>NO MITIGATION</u>
NA-0155a	Yes	Yes	Yes	-
55b	-	-	-	Yes
NA-0163	-	-	Yes	-
NA-0166	Yes	-	-	-
NA-0172a	-	Yes	Yes	-
72b	-	Yes	Yes	-
NA-0173	-	Yes	Yes	-
NA-0174	-	-	-	Yes
NA-0175	-	Yes	Yes	-
NA-0179	-	-	-	Yes
NA-0180	-	-	Yes	-



# THE NAVAJO NATION

NAVAJO NATION MINERALS DEPARTMENT  
P.O. Box 146  
Window Rock, Arizona 86515  
(602)-871-6587, FAX (602)-871-7095

P.O. BOX 308 • WINDOW ROCK, ARIZONA 86515 • (602) 871-4941

PETERSON ZAH  
PRESIDENT

MARSHALL PLUMMER  
VICE PRESIDENT

February 28, 1992

Dr. Michael Morales  
Associate Curator of Geology  
Museum of Northern Arizona  
Route 4 Box 720  
Flagstaff, AZ 86001

Dear Dr. Morales:

The Navajo Nation Minerals Department has reviewed your request for a permit to conduct a paleontological survey on the Navajo Reservation. Receipt of the \$100.00 permit application fee is hereby acknowledged, and a field reconnaissance Paleontological Permit is hereby granted for you, Mr. Randy Kirby, and Ms. Patty Luttrell, to conduct paleontologic investigations at 27 abandoned uranium mine sites near Cameron, Arizona on the Navajo Reservation.

This permit is subject to the following conditions:

1. The rights of local Navajo people will be respected and protected.
2. The applicable laws of the Navajo Nation will be obeyed.
3. Personnel of the Minerals Department retain the right to accompany and monitor the field work. Please contact the Minerals Department at (602)-872-6587 at least three (3) working days prior to the field work.
4. The field work will be conducted at your own risk and the Navajo Nation will not be held liable for any personal injury or property damage that might occur during the course of your field work.
5. Vehicle access to all field localities will be restricted to existing roads and trails.

Ltr. to Dr. Morales  
February 28, 1992  
Page Two

6. Sampling will be restricted to areas disturbed by the proposed reclamation activity. Sampling of sedimentary rock will not result in any significant surface disturbance and the total collection shall be limited to average hand sized samples, not more than 100 pounds in aggregate.
7. The disturbance, collection, or quarrying of in-situ vertebrate paleontologic remains is not permitted.
8. The disturbance, collection, or quarrying of archaeological remains is not permitted.
9. All samples collected remain the property of the Navajo Nation and shall be returned to the Nation upon request. Any paleontologic specimens recovered from the construction area during the survey will be the property of the Navajo nation, and may be prepared, curated, and stored at the Museum of Northern Arizona in Flagstaff Arizona, until such time that the Navajo Nation requests the return of the specimens.
10. All data obtained from samples and paleontologic and geological observations on Navajo land will be provided to the Minerals Department. A detailed report of the activities and results of the investigations are to be provided to the Minerals Department upon completion of the work.
11. All reports resulting from the field work on Navajo land will be reviewed and approved by the Minerals Department prior to any publication. A complete copy of any manuscript, report, abstract, etc., resulting from the field work will be submitted to the Minerals Department, P.O. Box 146, Window Rock, Arizona, 86515, upon completion for review and approval prior to publication.
12. The permittee will be liable for any damages to the Navajo Nation, its residents, or property resulting from the negligence of the permittee.
13. This permit is effective from March 1 through May 30, 1992.

Please signify your concurrence with the conditions of this permit by signing below and returning one signed original copy of this permit to the Minerals Department. This permit will not be considered valid until the signed original copy is received by the Minerals Department.

Ltr. to Dr. Morales  
February 28, 1992  
Page Three

If you have any questions or comments, please do not hesitate to contact me or Mr. Brad Nesemeier, Geologist at (602) 871-6587.

Sincerely,

MINERALS DEPARTMENT

*Akhtar Zaman*  
Akhtar Zaman  
Director

*Michael Morales*  
Mr. Michael Morales

*March 3 1992*  
Date

xc: Anderson Morgan, Executive Director, Division of Natural  
Resources, The Navajo Nation.  
Henry Deal, Director, Resource Enforcement Agency,  
Division of Natural Resources, The Navajo Nation



## **APPENDIX C**

**THREATENED AND ENDANGERED SPECIES SURVEY AND  
BIOLOGICAL EVALUATION**

**AND**

**THREATENED AND ENDANGERED SPECIES SURVEY AND  
BIOLOGICAL EVALUATION: GOLDEN EAGLE AND FERRUGINOUS  
HAWK**

**THREATENED AND ENDANGERED SPECIES SURVEY  
AND BIOLOGICAL EVALUATION**

**for:**

**NAVAJO ABANDONED MINE LAND RECLAMATION  
DEPARTMENT**

**project:**


**CAMERON PROJECTS III AND IV:  
ABANDONED URANIUM PITS**

**Submitted by:**


**NAVAJO FISH & WILDLIFE DEPARTMENT  
BIOLOGICAL SURVEY SERVICES  
P.O. BOX 1480  
WINDOW ROCK, ARIZONA 86515**

**NOVEMBER 9, 1993**

Report prepared by:

  
Steven Chischilly, Biologist  
Biological Survey Services  
Navajo Fish & Wildlife Department

C O N C U R R E N C E:

  
Larry Benallie, Sr., Director  
Navajo Fish & Wildlife Department

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV,  
October 1993.

Table of Contents

INTRODUCTION.....	4
METHODS.....	5
RESULTS.....	6
CONCLUSIONS.....	8
RECOMMENDATIONS.....	10
REFERENCES.....	10

List of Tables

Table 1. Cameron Projects III and IV sites.....	5
Table 2. Species of Concern.....	6
Table 3. Dominant vegetation occurring on or in the vicinity of the Cameron Project III and IV projects sites...	7
Table 4. Animal species found or occur, by sign or observation, on or in the vicinity of the Cameron III and IV project sites.....	8
Table 5. Distances from project sites to golden eagle suitable nesting habitat on Black Point.....	8

List of Figures

Figures 1-5. Location and approximate boundary of Cameron AML Projects III and IV project areas.....	attached
---	----------

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV, October 1993.

## INTRODUCTION

The Biological Survey Services Program (BSSP) of the Navajo Fish & Wildlife Department (NFWD) was contracted by the Tuba City field office of the Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) to conduct a threatened and endangered (T&E) species survey for the abandoned uranium mines which make up the Cameron projects III and IV. Cameron project III consists of 9 abandoned mines and Cameron project IV consists of 13 sites. The T&E survey is required as part of the Environmental Assessment (EA) process.

Cameron projects III and IV are scattered near Cameron, Arizona on the Navajo Nation. Cameron is approximately 50 miles north of Flagstaff, Arizona. The site locations range from approximately 6.5 miles east northeast of Cameron to 6 miles southeast of Cameron (Figures 1-5).

The objective of the T&E survey is to determine the status of federally and tribally listed T&E species in and around the proposed reclamation project sites and assess any impacts to those species as a result of these projects. A general description of the study areas and accompanying vegetation is provided, and habitat that is deemed critical to a particular species, or group of species, will be identified. Recommendations for mitigation and avoidance measures to eliminate negative impacts to T&E species, species of concern, or critical habitat, will be provided if applicable.

The project areas contain the following features: open adits; prospect adits; partially collapsed adits; rimstrips; trenches; and associated spoil piles. Proposed activities to reclaim these features include backfilling, re-excavation of improperly backfilled portals, and drilling. Other activities include: diversion channels and/or berms, check dams, construction of replacement dams, and upgrading of access roads.

The project areas are located on three USGS 7.5" quadrangles: Cameron North, Cameron SE, and Wupatki NE.

Project site number, site name, site acreage and associated USGS quadrangle are listed in Table 1 for Cameron projects III and IV.

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV,  
October 1993.

Table 1. Cameron Projects III and IV reclamation sites.

<u>Number</u>	<u>Name</u>	<u>Acres</u>	<u>USGS 7.5' Map</u>
CAMERON III			
1.NA-0155a	Charles Huskon No. 10	25.92	Cameron SE
NA-0155b		12.38	Cameron SE
2.NA-0163	Ryan No. 1	7.51	Cameron SE
3.NA-0166	Charles Huskon No. 11	25.36	Cameron SE
4.NA-0172a	RAMCO No. 21	15.29	Wapatki NE
NA-0172b		18.76	
5.NA-0173	RAMCO No. 22	20.25	Wupatki NE
6.NA-0174	RAMCO No. 20	15.11	Wupatki NE
7.NA-0175	Ryan No. 2	105.83	Wupatki NE
8.NA-0179	Yazzie No. 1	7.89	Wupatki NE
9.NA-0180	Yazzie No. 2	32.60	Wupatki NE
TOTAL ACRES		286.88	
CAMERON IV			
1.NA-0124	Jack Daniels No.1-5	56.03	Cameron North
2.NA-0131	Max Johnson No. 9	26.79	Cameron North
3.NA-0134	Alyce Tolino No 1 & 3	33.59	Cameron North
4.NA-0137	Yazzie No. 312	31.70	Cameron SE
5.NA-0145	Manuel Denetsone No. 2	1.00	Cameron SE
6.NA-0184	Charles Huskon No. 17	18.64	Wupatki NE
7.NA-0186	Jackpot No. 1	4.03	Wupatki NE
8.NA-0187	Jackpot No. 5	4.42	Wupatki NE
9.NA-0194	Julius Chee No. 3	40.99	Wupatki NE
10.NA-0195	Julius Chee No. 2	13.11	Wupatki NE
11.NA-0196a	RAMCO No. 24	32.20	Wupatki NE
12.NA-0197	Charles Huskon No. 4	85.10	Wupatki NE
NA-0198	Paul Huskie No. 3		
13.NA-0199x	Emmett Lee No. 3	19.77	Wupatki NE
TOTAL ACRES		367.37	

TOTAL ACREAGE FOR BOTH PROJECTS: 654.25

#### METHODS

Steven Chischilly, Biologist, Biological Survey Services met with Tony Robbins of the Tuba City AML field office on June 29, 1993 in Tuba City. This meeting was to acquaint Chischilly with the mine sites and the methods of reclamation.



T & E Species Evaluation, NFWD, NAML Cameron Project III & IV, October 1993.

The project sites of Cameron III and IV were surveyed on June 29, 30 and July 1 and 2 by hiking and observing the sites as well as the perimeter of the project areas. Plants and animals were identified either on sight, tracks, call or by scat. Plants not identifiable in the field were collected for later identification in the laboratory.

## RESULTS

Species of concern were identified by the Navajo Natural Heritage Program database (Table 2). These species have the potential to occur within or in the vicinity of the project area.

---

Table 2. Species of concern identified as having potential to occur in the project areas by the NNHP database for the Cameron III and IV reclamation project sites.

NA-0124, 0131, 0134, 0137 sites:

1. Amsonia peeblesii (Peebles blue-star); NESL group 4; USESA category 3C.
2. Astragalus beathii (Beath milk-vetch).
3. Cymopterus megacephalus (Bighead water parsnip); NESL group 4, USESA category 2 candidate.
4. Phacelia welshii (Welsh phacelia); NESL group 4; USESA category 2 candidate.
5. Rana pipiens (Leopard frog); NESL group 4.
6. Pediocactus peeblesianus var. fickeiseniae (Fickeisen plains cactus); NESL group 3; USESA category 1 candidate.
7. Aquila chrysaetos (Golden eagle); NESL group 3; MBTA; BEA.
8. Buteo regalis (Ferruginous hawk); NESL group 3; USESA category 2 candidate; MBTA.

NA-0155a,b, 0163, 0166:

1. Astragalus sophoroides (Painted Desert milk-vetch).
2. Aquila chrysaetos (Golden eagle); NESL group 3; MBTA; BEA.
3. Buteo regalis (Ferruginous hawk); NESL group 3; USESA category 2 candidate; MBTA.

NA-0172a,b, 0173, 0174, 0175, 0179, 0180, 0184, 0186:

1. Astragalus sophoroides (Painted desert milk-vetch).
2. Speotyto cunicularia (Burrowing owl); MBTA.
3. Aquila chrysaetos (Golden eagle); NESL group 3; MBTA; BEA.
4. Buteo regalis (Ferruginous hawk); NESL group 3; USESA category 2 candidate; MBTA.
5. Mustela nigripes (Black-footed ferret); NESL group 2; USESA endangered.

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV,  
October 1993.

NA-0194, 0195, 0196a, 0197, 0199x:

1. Psorothamnus thompsonae var. whitingii (Whiting indigo bush); NESL group 4; USESA category 2 candidate.

Table 2. Continued.

2. Speotyto cunicularia (Burrowing owl); MBTA.
3. Aquila chrysaetos (Golden eagle); NESL group 3; MBTA; BEA.
4. Buteo regalis (Ferruginous hawk); NESL group 3; USESA category 2 candidate; MBTA.
5. Mustela nigripes (Black-footed ferret); NESL group 2; USESA endangered.

All sites:

1. Gila cypha (Humpback chub); NESL group 2; USESA endangered. Of additional concern due to the possibility of affecting the riparian habitat of the Little Colorado River.

---

The vegetation type characteristic of the Cameron III and IV problem areas as described by Brown (1982) is Great Basin Desertscrub of the shadscale series (Table 2). The areas are located in the Painted Desert of the Navajo Nation, a cold temperate desert. The open pits with standing water had Salt Cedar (Tamarix chinensis) growing on the pond banks. Areas recently disturbed were characterized by Russian Thistle (Salsola sp.). Most of the tailing piles were devoid of plant life. At the time of the survey no plant species of concern were identified from any of the sites.

---

Table 3. Dominant vegetation occurring on or in the vicinity of the Cameron III and IV project sites.

Sites NA-0155a,b, -0166:

Shadscale (Atriplex confertifolia)  
Broom Snakeweed (Gutierrezia sarothrae)  
Camelthorn (Alhagi camelorum)  
Indian Ricegrass (Oryzopsis hymenoides)  
Blue Grama (Bouteloua gracilis)  
Hopi Blanket Flower (Gaillardia pinnatifolia)  
Sunflower (Helianthus helioides)  
Annual Buckwheat (Areionum divaricatum)  
Globemallow (Sphaeralcea sp.)  
Mormon Tea (Ephedra sp.)  
Soapweed (Yucca sp.)

All other sites:

Indian Ricegrass (Oryzopsis hymenoides)  
Broom Snakeweed (Gutierrezia sarothrae)

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV,  
October 1993.

Rubber Rabbitbrush (Chrysothamnus nauseosus)  
Shadscale (Atriplex confertifolia)  
Soapweed (Yucca sp.)  
Mormon Tea (Ephedra sp.)  
Prickly Pear Cactus (Opuntia sp.)  
Hopi Blanket Flower (Gaillardia pinnatifolia)  
Foxtail Barley (Hordeum jubatum)  
Salt Cedar (Tamarix chinensis)

---

Those animals identified as inhabiting the Cameron III and IV  
project areas are listed in Table 4.

---

Table 4. Animal species found to occur, by sign or  
observation, on or in the vicinity of the Cameron III and IV  
reclamation area.

Mammals:

Coyote (Canis latrans)  
Red Fox (Vulpes fulva)  
Cottontail Rabbit (Sylvilagus sp.)  
Black-tailed Jackrabbit (Lepus californicus)  
Badger (Taxidea taxus)

Birds:

Common Raven (Corvus corax)  
Say's Phoebe (Sayornis saya)  
Mourning Dove (Zenaida macroura)  
Horned Lark (Eremophila alpestris)

Reptiles:

Side-blotched Lizard (Uta stansburiana)

---

Cliffs of sufficient size to provide eagle nesting habitat  
exists in the vicinity of the project areas. An archaeological  
survey made notice of the fact that eagles were suspected to be  
nesting in the vicinity (Hopi HPD, 1993). Eagles are suspected to  
nest upon Black Point (Hopi HPD, 1993). Specific nesting locations  
were not attained. Distances from projects site locations were  
calculated for mitigative purposes (Table 5).

---

Table 5. Approximate distance from project sites to an area on Black Point which may provide suitable Golden eagle nesting habitat. Sites not listed are of sufficient distance from Black Point and construction of these sites would not pose a threat to eagles nesting on Black Point.

<u>Site Number</u>	<u>Miles</u>
NA-0179, 0180, 0186, 0187	2.0
NA-0155a,b	4.0
NA-0166	3.0
NA-0172a,b, 0173, 0174, 0175	3.0
NA-0179, 0180, 0194, 0195	2.0
NA-0197, 0198	2.0
NA-0196a, 0199x	3.25

---

#### CONCLUSIONS

No plants of concern were found in and or in the vicinity of the proposed Cameron III and IV reclamation sites at the time of this survey. No plant species of concern are expected to be negatively affected by the construction of these projects.

Eagles nest from the beginning of March through August (Ryan, NNHP Zoologist, 1993). Eagles most likely use the area in and around the project areas for foraging and use the volcanic and sandstone cliffs for nesting. Project sites NA-0179, 0180, 0166, 0172(a&b), 0173, 0174, 0175, 0179, 0180, 0194, 0195, 0197, 0198, 0196a, and 0199x are in relatively close proximity to the volcanic plug. Golden eagles are highly susceptible to disturbance during the breeding season. Cameron projects III and IV may effect eagles found in this area if blasting and other construction is done during the breeding season.

For mitigative purposes it is recommended that the suspected nesting area be visited in mid to late March 1994 to determine if there are eagles nesting on or in the vicinity of Black Point. If it is determined that eagles are nesting on Black Point then a 1.5 mile buffer should be established from the nest and no construction should take place within this buffer during the breeding season. If the nest is within line of sight of construction then it is recommended that a 2.5 mile buffer be established with no construction during the breeding season (Suter, 1981). If a survey is completed and it is determined that there are no eagles nesting



T & E Species Evaluation, NFWD, NAML Cameron Project III & IV, October 1993.

there in 1994 then construction may commence with no negative effects expected upon the golden eagle.

Ferruginous hawks were not observed during the time this survey was conducted. Cliffs of sufficient size are located within the vicinity of the project areas. Badland topography which ferruginous hawks prefer for nesting is found in the Cameron area. Ferruginous hawks most likely use the area in and around the proposed project sites for nesting and the grassland to the south for foraging. Ferruginous hawk nesting season is from March through mid-July (Ryan, pers. comm., 1993).

A survey will be conducted for the nesting ferruginous hawk in the project vicinity as well as on Black Point. No negative impacts is expected upon the ferruginous hawk if no nests are found closer than 1 mile from the proposed construction sites (Suter, 1981).

No burrowing owls were found in the project sites or in the vicinity of these project sites. Burrowing owl inhabit prairie dog, badger, and kangaroo rat burrows and are closely associated with these species. Burrows found around these sites were not inhabited by burrowing owls nor were there any signs of their presence. No negative effects are expected with the construction of these projects upon the burrowing owl.

Black-footed ferrets are closely associated with prairie dog towns for prairie dogs are their primary food source. According to Navajo Fish & Wildlife guidelines (NFWD, 1985) a prairie dog town is to be investigated for black-footed ferret inhabitation if the prairie dog town exceeds 10 acres in size or if the cumulative occurrence of towns closely associated with one another encompasses more than 120 acres. Prairie dog towns found at the project sites were not in excess of 120 acres. Due to the lack of extensive prairie dog towns greater than 120 acres in size no negative effect upon the black-footed ferret is expected with the construction of the Cameron III and IV projects.

Leopard frogs have the potential to exist within the ponds found in some of the project sites. No leopard frogs were observed during this survey. These ponds were created as a result of the mining and are radioactively contaminated. There are health hazards associated with the presence of these ponds and the benefits gained with the reclamation of these ponds outweighs the benefits created by the ponds. The contaminated water sources will be replaced with other livestock watering ponds with presumably uncontaminated water. Direct impacts to the leopard frog are expected to be minimal from these projects.



T & E Species Evaluation, NFWD, NAML Cameron Project III & IV, October 1993.

The Little Colorado River flows through the Cameron III and IV project areas. The Little Colorado River is important habitat for the endangered Humpback Chub (*Gila cypha*). The Little Colorado River contains the largest known breeding population of humpback chub in the lower Colorado River Basin. This population is susceptible to contaminants from any drainage which feed the Little Colorado River. Potential bioaccumulation of radioactive elements and the corresponding negative physiological effects should be addressed (Wrenn, 1987, Poston, 1984). Potential uranium contamination from tailing piles of the Little Colorado River and the potential negative effects upon ichthyofauna, both during construction and post-construction, should be addressed.

#### SUMMARY/RECOMMENDATIONS

No plant species of concern were found in the projects sites or in the project site vicinity. No negative impacts upon these species is expected with the construction of these sites.

Eagles are suspected to nest on Black Point which is in the vicinity of the project sites. A 1.5 mile buffer should be established around the nest site if a nest site is found. No construction activities should be conducted within this buffer between the dates of March 1 through August 31. If construction outside of this 1.5 mile buffer is in direct line of site of the nest then a 2.5 mile buffer is recommended. The use of heavy equipment, drilling, and blasting should be avoided until after August 31 at sites which fall within the buffer zones.

A survey for golden eagles will be conducted in mid to late March 1994 to determine if Black Point is used for nesting by this species. If no nesting golden eagles are found then no negative impacts are expected upon this species with the reclamation of the project sites.

The vicinity around the project sites will be searched for nesting ferruginous hawks during the same time period. If an active nest is found establishment of a one mile buffer is recommended for nesting ferruginous hawks with no construction within this buffer during respective breeding season. If no nesting ferruginous hawks are found then no negative impacts would be expected upon this species with the reclamation of these project sites.

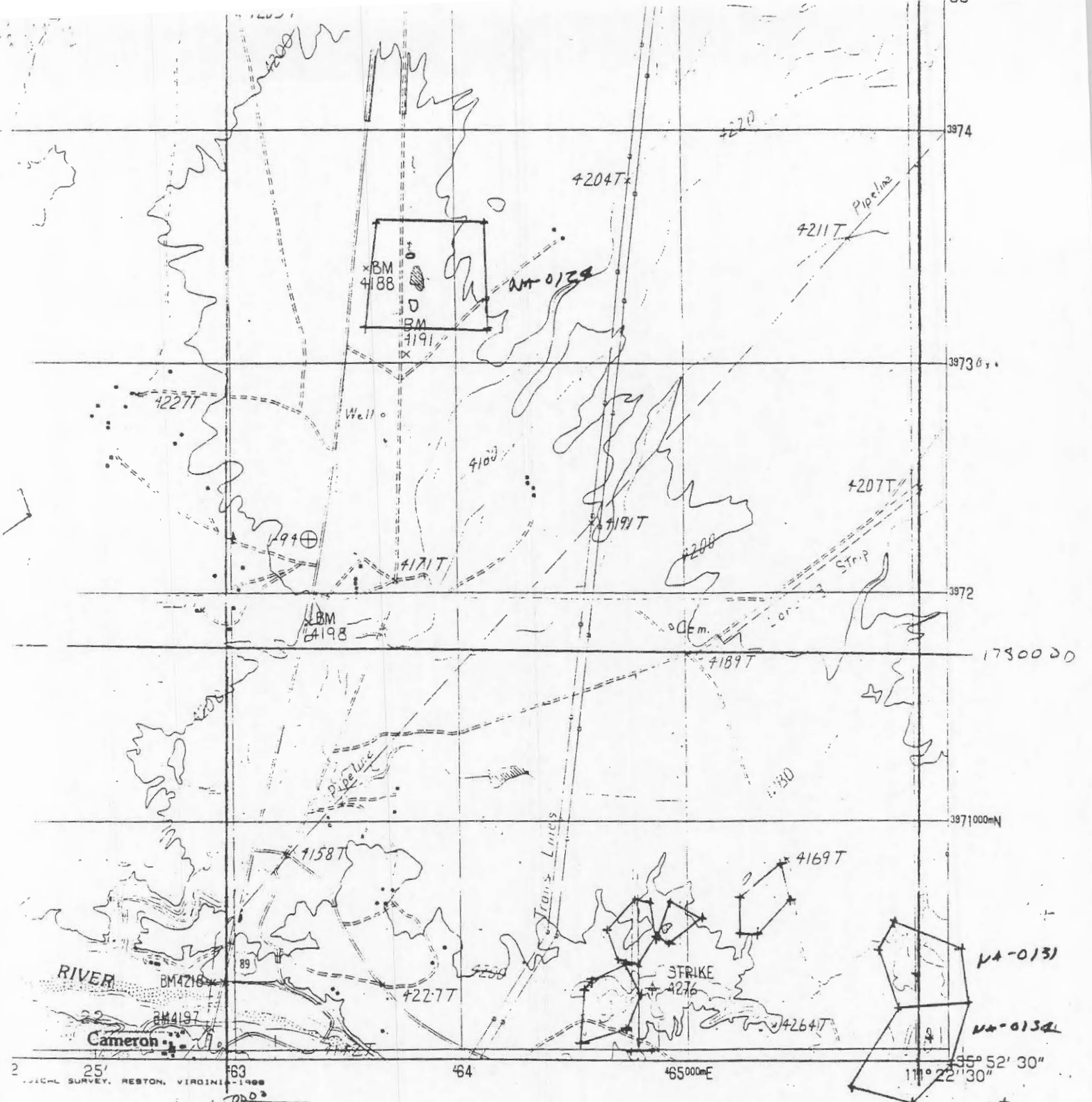
The Little Colorado River is important habitat for the endangered humpback chub. The potential for uranium contamination of the humpback chub within the Little Colorado River during and as a result of reclamation should be addressed.

T & E Species Evaluation, NFWD, NAML Cameron Project III & IV, October 1993.

NOTE: Raptor nest locations are given for management purposes only.

#### REFERENCES

- Brown, David E. 1982. Desert Plants: Biotic Communities of the American Southwest-United States and Mexico. University of Arizona Press. Vol. 4, Nos. 1-4.
- Bywater, John F., et. al. 1991. Sensitivity to Uranium of Six Species of Tropical Freshwater Fishes and Four Species of Cladocerans From Northern Australia. American Toxicology and Chemistry. Vol.10. pp. 1449-1458.
- Hopi Historic Preservation Department. 1993.
- Navajo Fish & Wildlife Department. 1985. Black-Footed Ferret Guidelines for the Navajo Indian Reservation. 7pgs.
- Posten, T.M., et. al. 1984. Toxicity of Uranium to Daphnia magna. Water, Air, and Soil Pollution. 22: 289-298.
- Ryan, Patrick F. 1993. Zoologist: Navajo Natural Heritage Program, Navajo Fish & Wildlife Department.
- Suter, Glenn W. and Jan L. Jones 1981. Criteria for Golden Eagles, Ferruginous Hawk, and Prairie Falcon Nest Site Protection. Raptor Research. pg. 12-18.
- Wrenn, McDonald E., et. al., 1987. The Potential Toxicity of Uranium in Water. American Waste Water Association.



2 25' 63 64 65000E



QUADRANGLE LOCATION

1	2	3	1 Blue Spring SE
			2 Shadow Mountain Well
			3 Moenave SE
4		5	4 Coconino Point
			5 Cameron NE
			6 Coconino Point SE
6	7	8	7 Cameron South
			8 Cameron SE

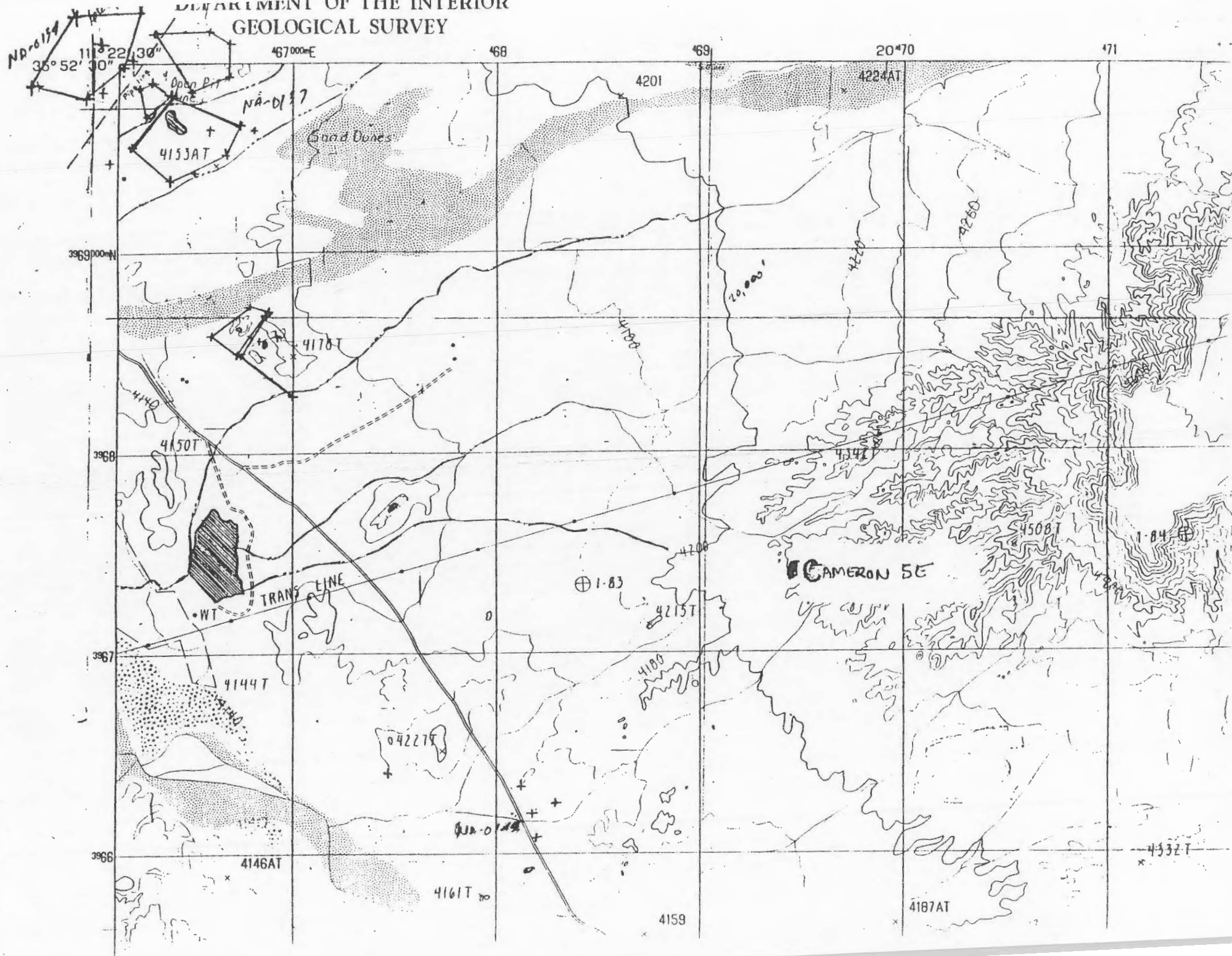
ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

- Improved Road . . . . .
- Unimproved Road . . . . .
- Trail . . . . .
- Interstate Route ○ U.S. Route ○ State Route

CAMERON NORTH, ARIZONA  
PROVISIONAL EDITION 1988

DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY





4301

NA-0172

NA-0173

NA-0174

NA-0175

4235

4287

4216

COLORADO

NA-0179

NA-0180

NA-0184

NA-0186

NA-0187

4365

4267

4213

4219

4245

4306

RIVER

Well

Borrow Pit

4214

TOHACHI

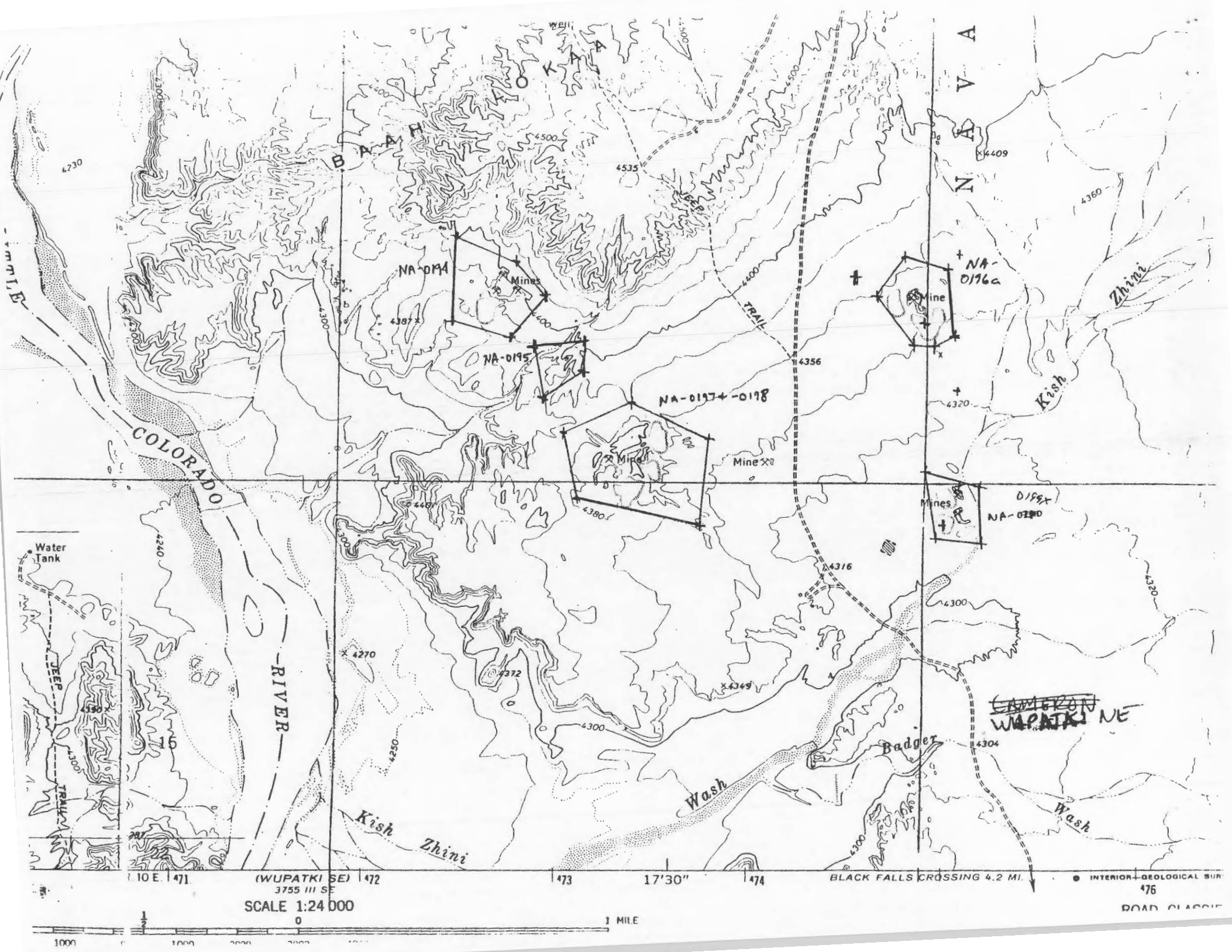
4251

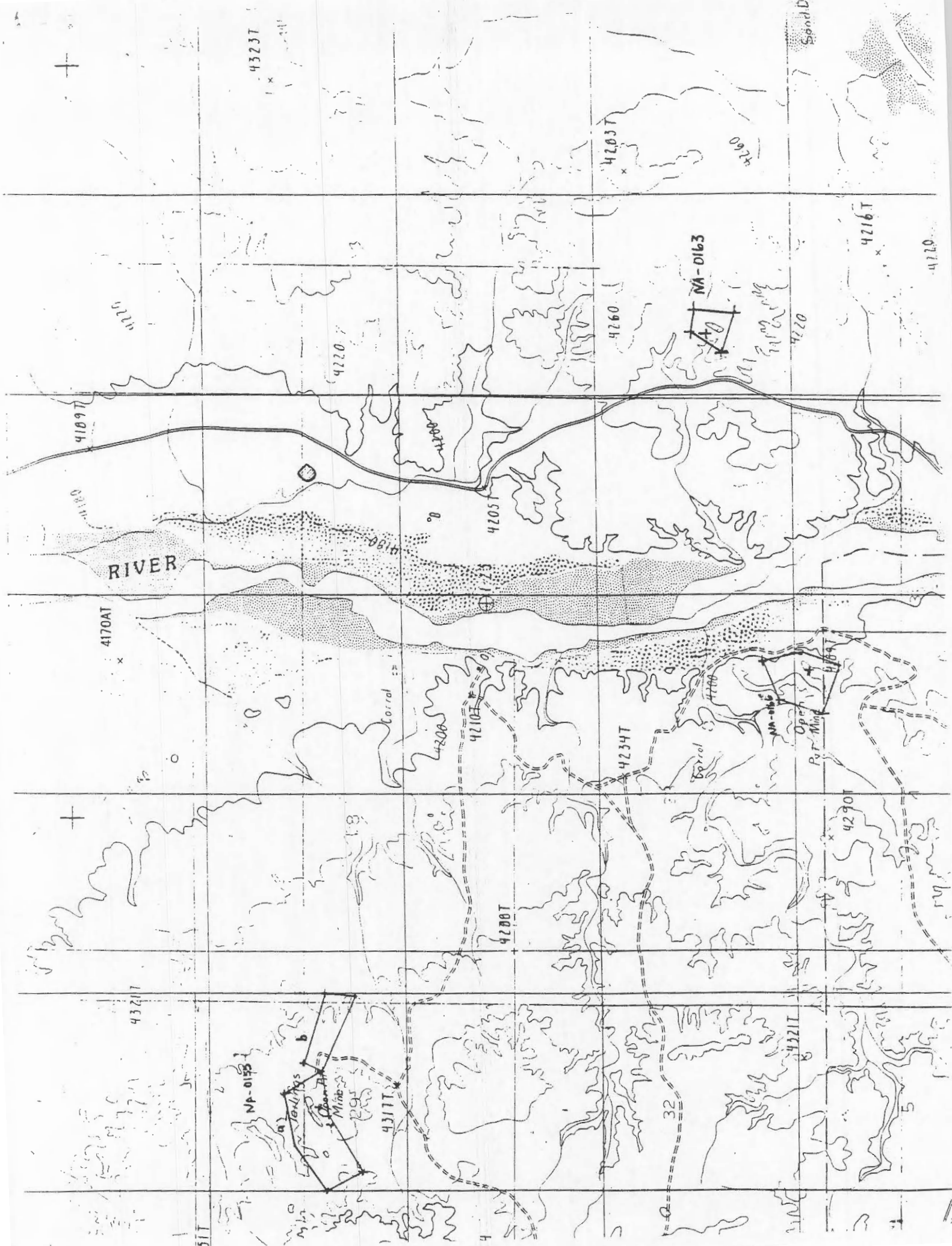
4288

4268

INTERVALE







T&E Species Evaluation, NFWD, NAML Cameron Project III & IV, May 1994.

THREATENED AND ENDANGERED SPECIES SURVEY AND  
BIOLOGICAL EVALUATION: GOLDEN EAGLE AND FERRUGINOUS  
HAWK

for:

NAVAJO ABANDONED MINE LAND RECLAMATION  
DEPARTMENT-TUBA CITY FIELD OFFICE

project:

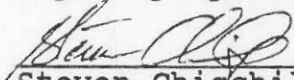
CAMERON III AND IV:  
ABANDONED URANIUM MINES

submitted by:

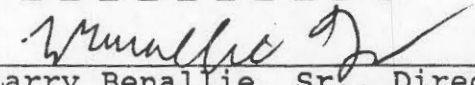
NAVAJO FISH & WILDLIFE DEPARTMENT  
BIOLOGICAL SURVEY SERVICES  
P.O. BOX 1480  
WINDOW ROCK, ARIZONA 86515

MAY 18, 1994

Report prepared by:

  
Steven Chischilly, Biologist  
Biological Survey Services  
Navajo Fish & Wildlife Department

C O N C U R R E N C E:

  
Larry Benallie, Sr., Director  
Navajo Fish & Wildlife Department

## INTRODUCTION

A golden eagle (Aquila chrysaetos) and ferruginous hawk (Buteo regalis) survey was conducted for the Navajo Abandoned Mine Lands Reclamation Department-Tuba City Field Office (NAMLRD-TCFO) Cameron Projects III & IV abandoned uranium mine sites and vicinity on April 19, 20, and 21, 1994 by Steven Chischilly, Biologist, with the Biological Survey Services Program (BSSP) of Window Rock, Arizona. These surveys were conducted to investigate the inhabitation or occurrence of the golden eagle and the ferruginous hawk within or adjacent to the proposed project sites. Of main concern was Black Point which is a lava flow mesa which provides potential nesting habitat for the golden eagle and the sandstone pinnacles which exist near the Little Colorado River (refer to attached map). These sandstone pinnacles provide potential nesting habitat for the ferruginous hawk.

The area surveyed for the occurrence or nesting of these species is located on the Wapatki, NE 7.5" USGS quadrangle (refer to attached map).

## METHODS

Steven Chischilly met with Tony Robbins, Reclamation Specialist II, and Raymond Tsinigine, Reclamation Specialist III, on April 20, 1994 at the Tuba City field offices. This meeting was held to acquaint Chischilly with the best access route to Black Point. It was decided that the most suitable access route to the survey area would be via the Spider Web Ranch which is located east of state highway 89. The turn off to the ranch is located approximately 5 miles south of Gray Mountain trading post on highway 89.

The volcanic flow mesa known as Black Point was surveyed via a hiking survey and with a spotting scope and binoculars. Jackrabbit wash was hiked as well as the mesas east of this wash. The basalt cliffs and the surrounding volcanic bench which are found on Black Point was hiked and scanned. The entire cliff ledge was hiked and scanned for the presence of nests.

The sandstone pinnacles were also searched via binoculars and spotting scope for the presence of nesting ferruginous hawks. Most of these sandstone pinnacles are located near the Little Colorado River.

## RESULTS

The vegetation type characteristic of the Cameron III and IV problem areas as described by Brown (1982) is Great Basin Desertscrub of the shadscale series. The problem areas are located



T&E Species Evaluation, NFWD, NAML Cameron Project III & IV, May 1994.

in the Painted Desert of the Navajo Nation. This desert is a cold temperate desert.

Plants and animals were identified either on sight, tracks, call or by scat (Table 1). Plants not identifiable in the field were collected for later identification in the laboratory.

Table 1. Plants and animals found in the vicinity of Black Point and the Little Colorado River.

Plants:

Shadscale (Atriplex confertifolia)  
Broom Snakeweed (Gutierrezia sarothrae)  
Camelthorn (Alhagi camelorum)  
Indian Ricegrass (Oryzopsis hymenoides)  
Blue Grama (Boutaloua gracilis)  
Hopi Blanket Flower (Gaillardia pinntifolia)  
Sunflower (Ilianthus heliardus)  
Annual Buckwheat (Areigonum divaricatum)  
Globemallow (Sphaeralcea sp.)  
Mormon Tea (Ephedra sp.)  
Soapweed (Yucca sp.)  
Rubber Rabbitbrush (Chrysothamnus nauseosus)  
Prickly Pear Cactus (Opuntia sp.)  
Foxtail Barley (Hordeum jubatum)  
Salt Cedar (Tamarix chinensis)  
Dune Broom (Parryella sp.)

Animals:

Raven (Corvus corax)  
Red-tailed Hawk (Buteo jamaicensis)  
Sharp Shinned Hawk (Accipiter striatus)  
Common Collared Lizard (Crotaphytus collaris)  
Loggerhead Shrike (Lanius ludovicianus)  
Bendire's Thrasher (Toxostoma bendirei)  
Black-throated Sparrow (Amphispiza bilineata)  
Canyon Wren (Catherpes mexicanus)  
Merlin (Falco columbarius)  
Pronghorn (Antilocapra americana)  
Mourning Dove (Zenaida macroura)  
Horned Lark (Eremophila alpestris)

No ferruginous hawks or golden eagles were observed during the survey for these species at the Cameron III and IV problem areas.



T&E Species Evaluation, NFWD, NAML Cameron Project III & IV, May 1994.

#### CONCLUSIONS

No ferruginous hawks or golden eagle nests were found during this survey nor were any ferruginous hawks or golden eagles seen. No significant negative impact is expected upon the golden eagle and the ferruginous hawk if construction at the NAMLRD Cameron III and IV project sites is done between May 1994 through February 1995.

It is recommended that additional monitoring be conducted if construction at the following project sites proceeds into the month of February 1995: NA-0179, -0180, -0184, -0186, -0187, -0194, -0195, -0197, and -0198.

#### REFERENCES

Brown, David E. 1982. Desert Plants: Biotic Communities of the American

## **APPENDIX D**

### **FORM A**

**LAND USER CONSENT: CONSENT TO ENTRY FOR RECLAMATION**

FORM A  
(Land User Consent)

Consent to Entry for Reclamation  
Cameron Project Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, Clay Bigman, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Nitaa tin hegaani and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

9-26-91      Clay B. [Signature]      77431      Resident 11/19/48  
Date      Land User Signature      Census No.      Permit No.  
(or Thumbprint)

9-26-91      [Signature]      3-unit 1  
Date      Grazing Committee      District No.  
or Land Board Member

11/18/91      [Signature]  
Date      Director of NAMLD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English ☐ this 26th day of September, 1991. (check where applicable)

[Signature]  
Field Agent Signature

AA/bt.738

FORM A  
(Land User Consent)

Consent to Entry for Reclamation  
Cameron Project Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, Grace Big Man, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at N'ta-tin ha-sa-an and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.



5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

*Wintersburg, Arizona*

9-26-91  
Date

*Wintersburg*  
Land User Signature *Right*  
(or Thumbprint) *Thumb*

081 875  
Census No.

Resident 194  
Permit No.

9-26-91  
Date

*Charles B. Smith*  
Grazing Committee  
or Land Board Member

3 - unit - 1  
District No.

11/18/91  
Date

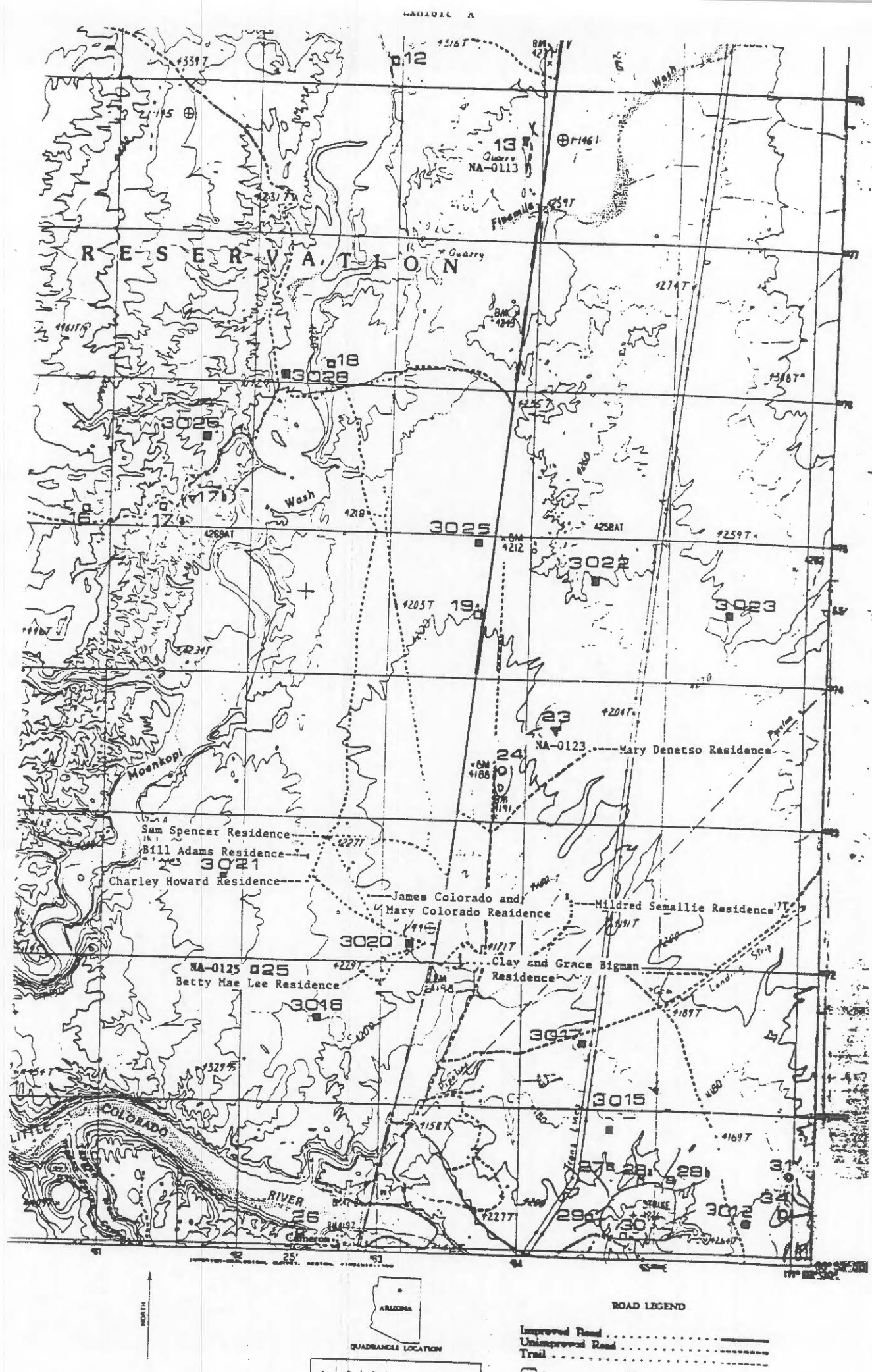
*Montezuma*  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English ☐ this 26th day of September, 1991 (check where applicable)

*John P. Smith*  
Field Agent Signature

AA/bt.738



FORM A  
(Land User Consent)

Consent to Entry for Reclamation

CAMERON ~~PROJECT~~ Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, ELWOOD CANYON, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Ndā tīnhaasānī <sup>(TANNER'S)</sup> <sub>(CROSSING)</sub> and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

9/11/91  
Date

*E. Wood*  
Land User Signature  
(or Thumbprint)

071977  
Census No.

3-0257  
Permit No.

9/11/91  
Date

*Henry J. Baldworth*  
Grazing Committee  
or Land Board Member

3-Unit 1  
District No.

11/18/91  
Date

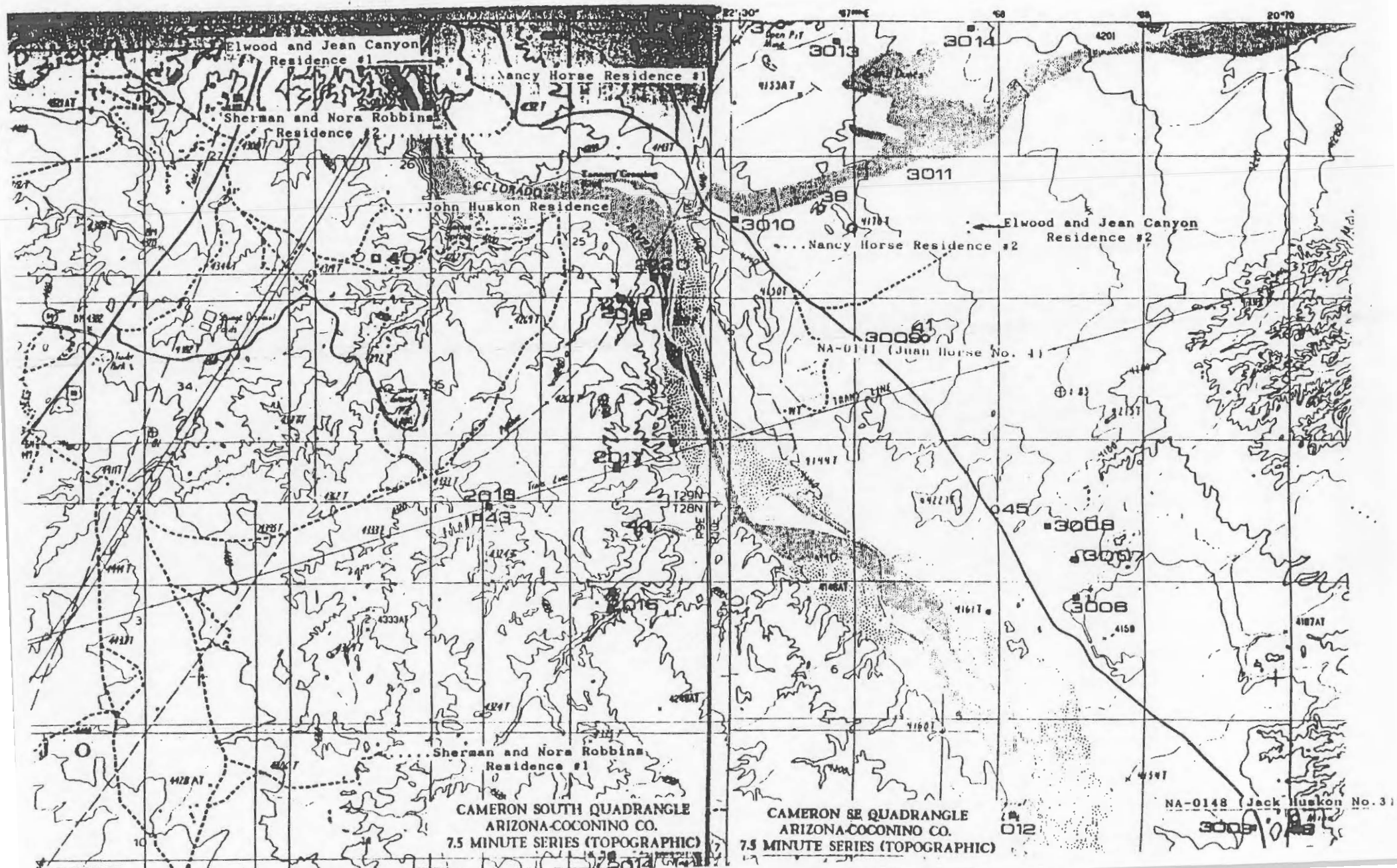
*Anthony*  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English ☐ this 11 day of September, 1991. (check where applicable)

*James P. Riddle*  
Field Agent Signature







FORM A  
(Land User Consent)

Consent to Entry for Reclamation

Cameron Project 1 ~~Project~~

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, Nancy Horse, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Nda'tiin ha sání (<sup>Fanner's</sup> ~~crossing~~) and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

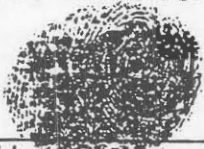
1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

9/15/91  
Date

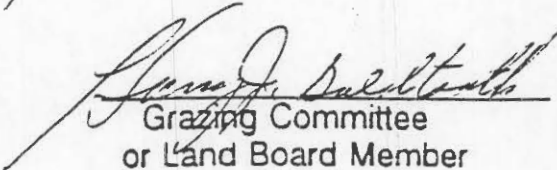
  
Land User Signature  
(or Thumbprint)

Right Thumb  
print of Nancy Horne  
Witnessed: Tony Robbins

78592  
Census No.

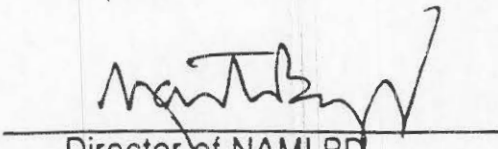
3-1405  
Permit No.

9-15-91  
Date

  
Grazing Committee  
or Land Board Member


3-1  
District No.

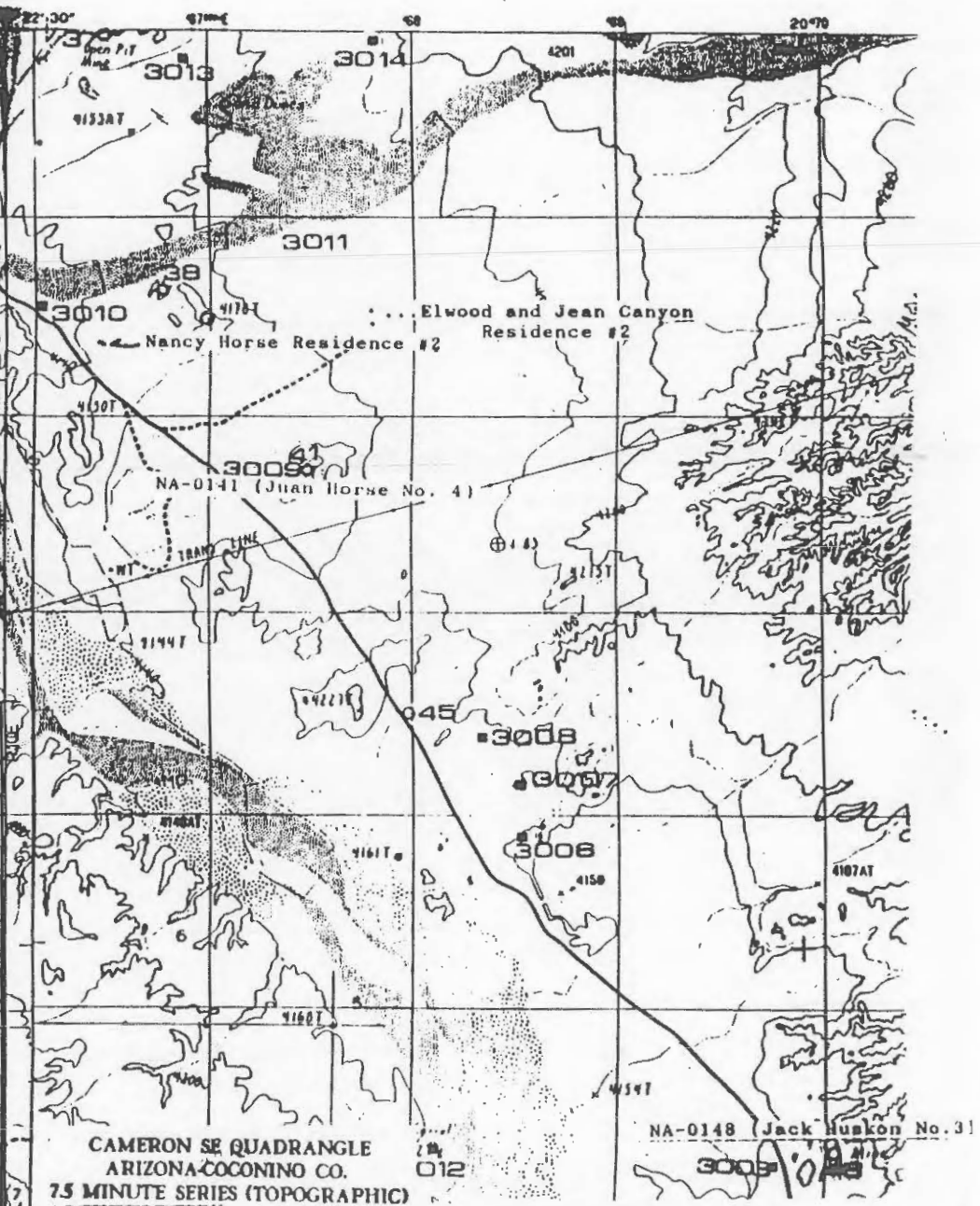
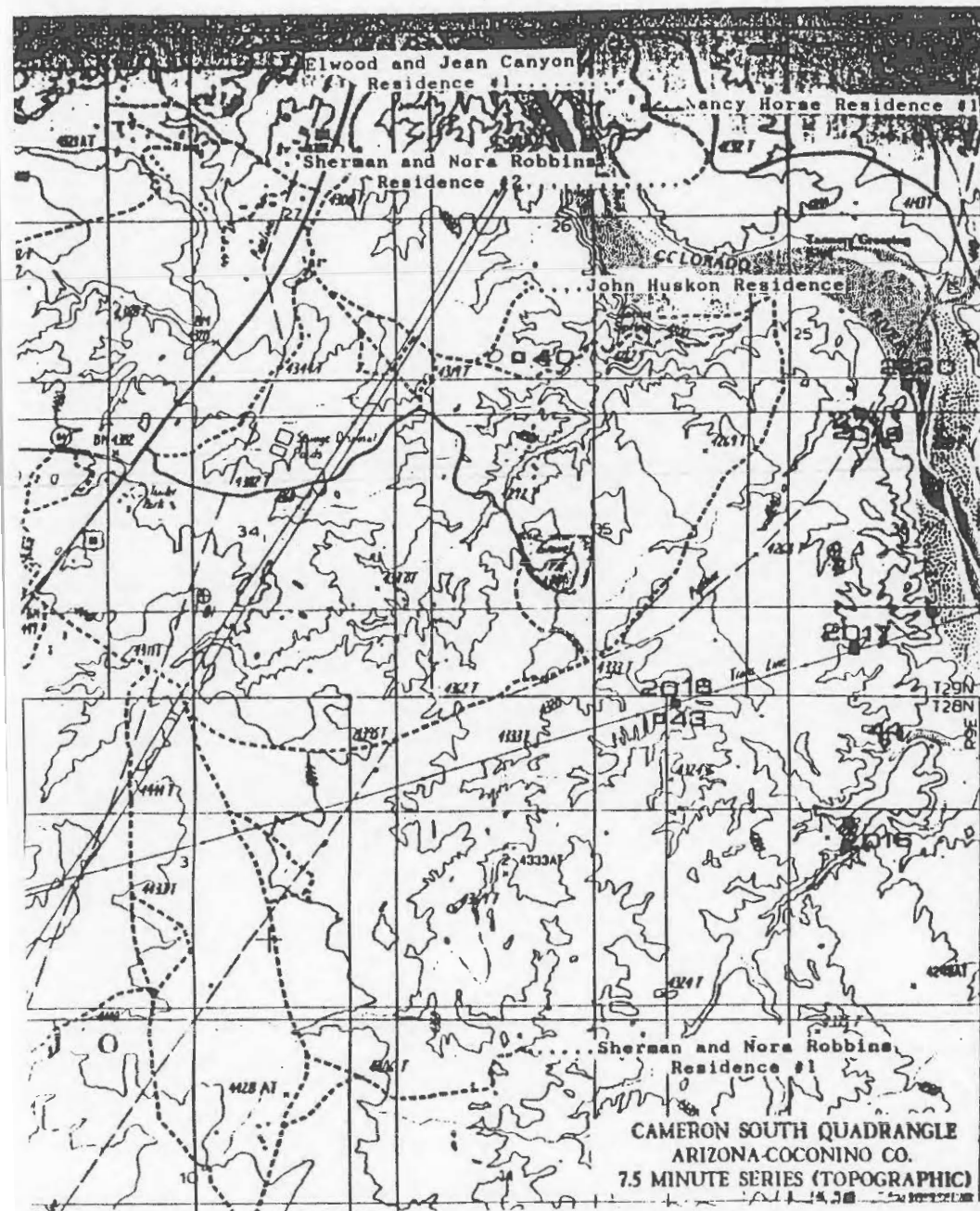
11/18/91  
Date

  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English ☐ this 11 day of September, 1991. (check where applicable)

  
Field Agent Signature



FORM A  
(Land User Consent)

Consent to Entry for Reclamation  
Cameron Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, Betty B. Huskon, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Hal gai toh and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

02/12/92  
Date

B. H. B. Nelson  
Land User Signature  
(or Thumbprint)

077,649  
Census No.

3-414  
Permit No.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Grazing Committee  
or Land Board Member

\_\_\_\_\_  
District No.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Director of NAMLRD

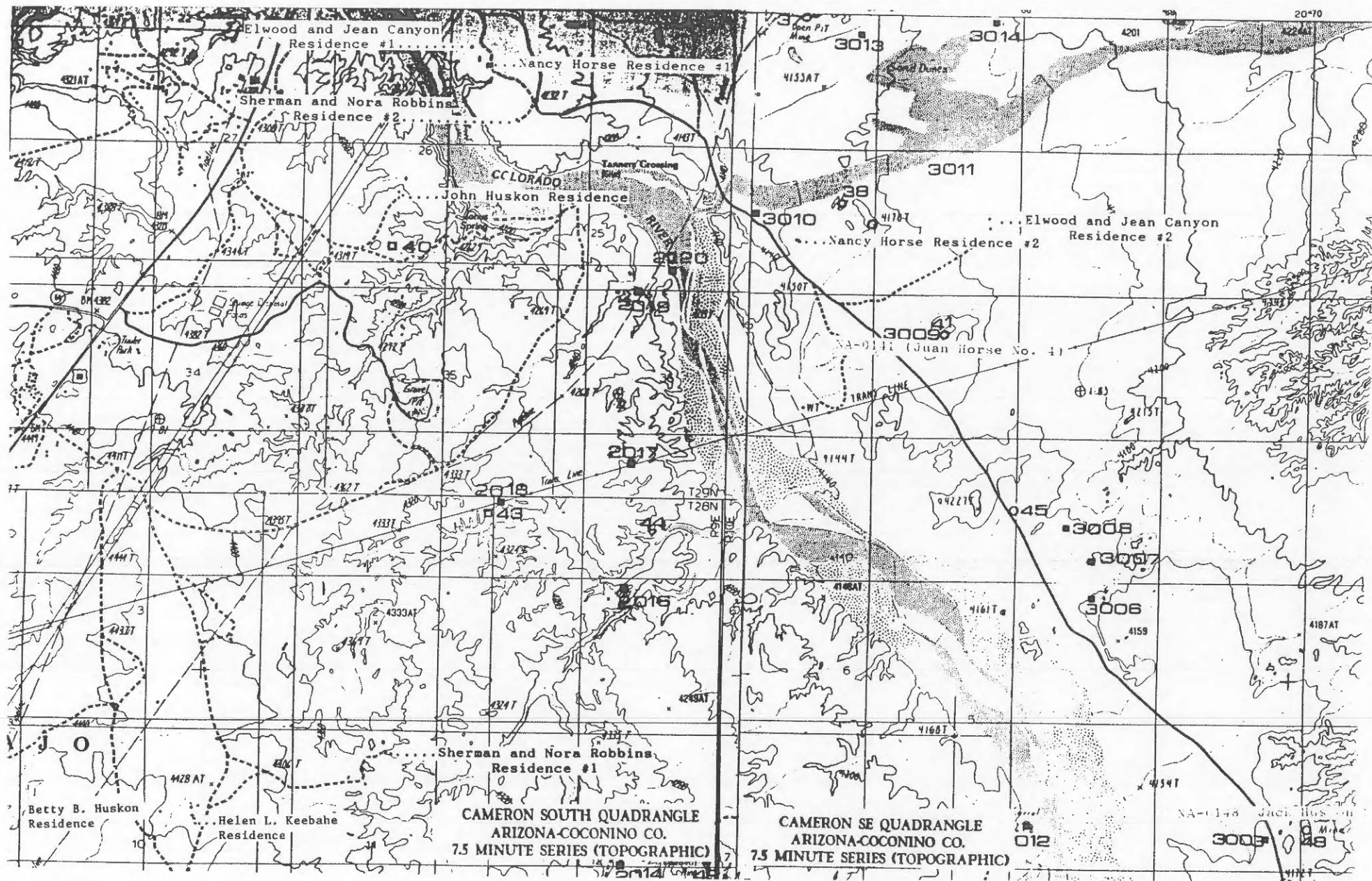
#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English \_\_\_\_\_ this 12th day of February 1993, 19 \_\_\_\_ . (check where applicable)

Gary Rollins, Rec. Spec. II  
Field Agent Signature

AA/bt.738





\* ← Hui gni toh (approx)

FORM A  
(Land User Consent)

Consent to Entry for Reclamation

Cameron Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, John Huskon, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Mine # 141 & 148 and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

Sept. 24 1991  
Date

John H. Hoken  
Land User Signature  
(or Thumbprint)

077.58  
Census No.

3-1019  
Permit No.

9-26-91  
Date

Samuel P. Hoken  
Grazing Committee  
or Land Board Member

3-1  
District No.

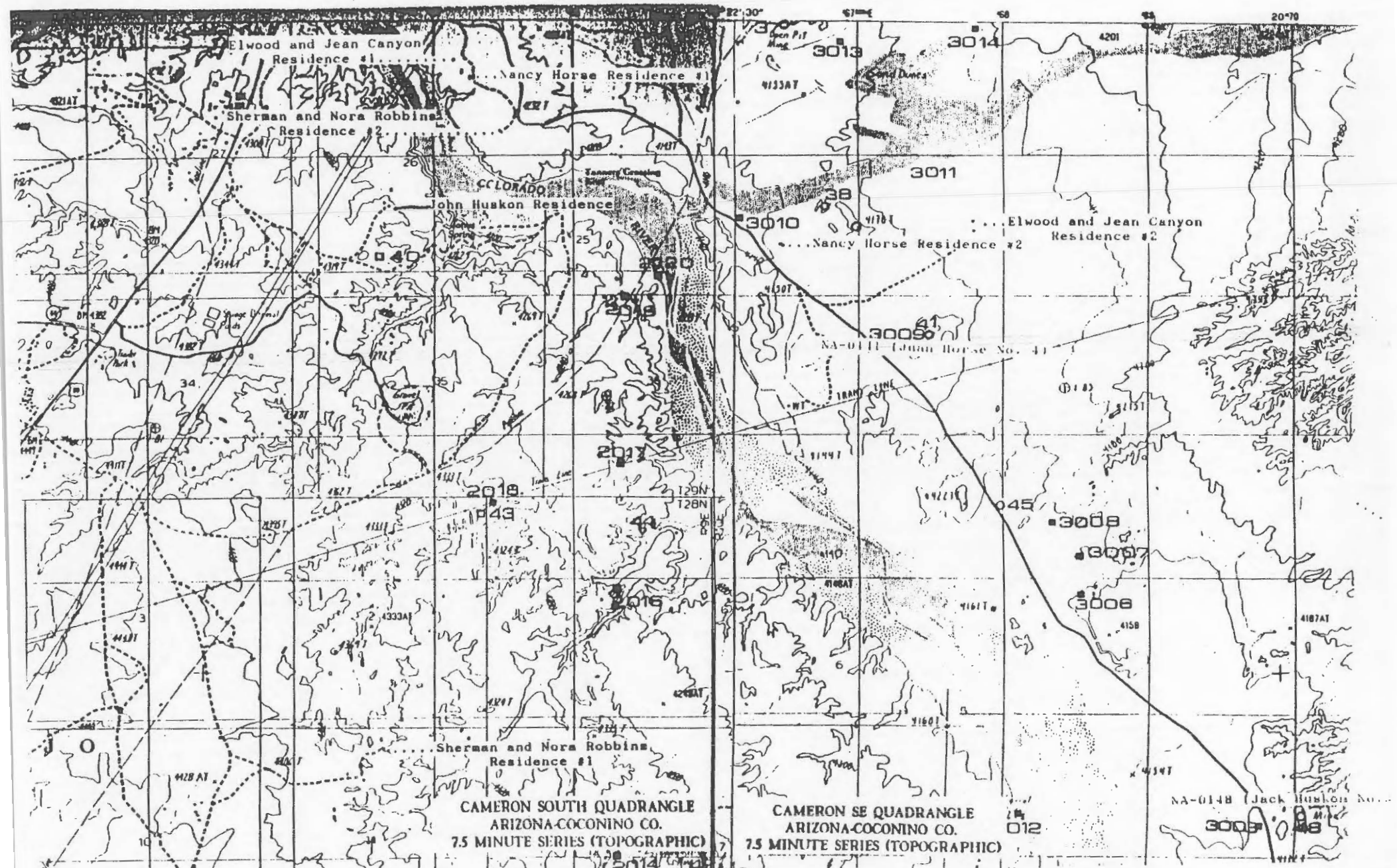
11/18/91  
Date

Mark B. Hoken  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English ☐ this 26th day of September, 1990. (check where applicable)

Samuel P. Hoken  
Field Agent Signature





FORM A  
(Land User Consent)

Consent to Entry for Reclamation

Cameron AML Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, Helen L. Keebake, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Hul gai toh and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.



5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

02/12/93  
Date

Helen Y. Keenbahe  
Land User Signature  
(or Thumbprint)

72,842  
Census No.

3-1645  
Permit No.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Grazing Committee  
or Land Board Member

\_\_\_\_\_  
District No.

\_\_\_\_\_  
Date

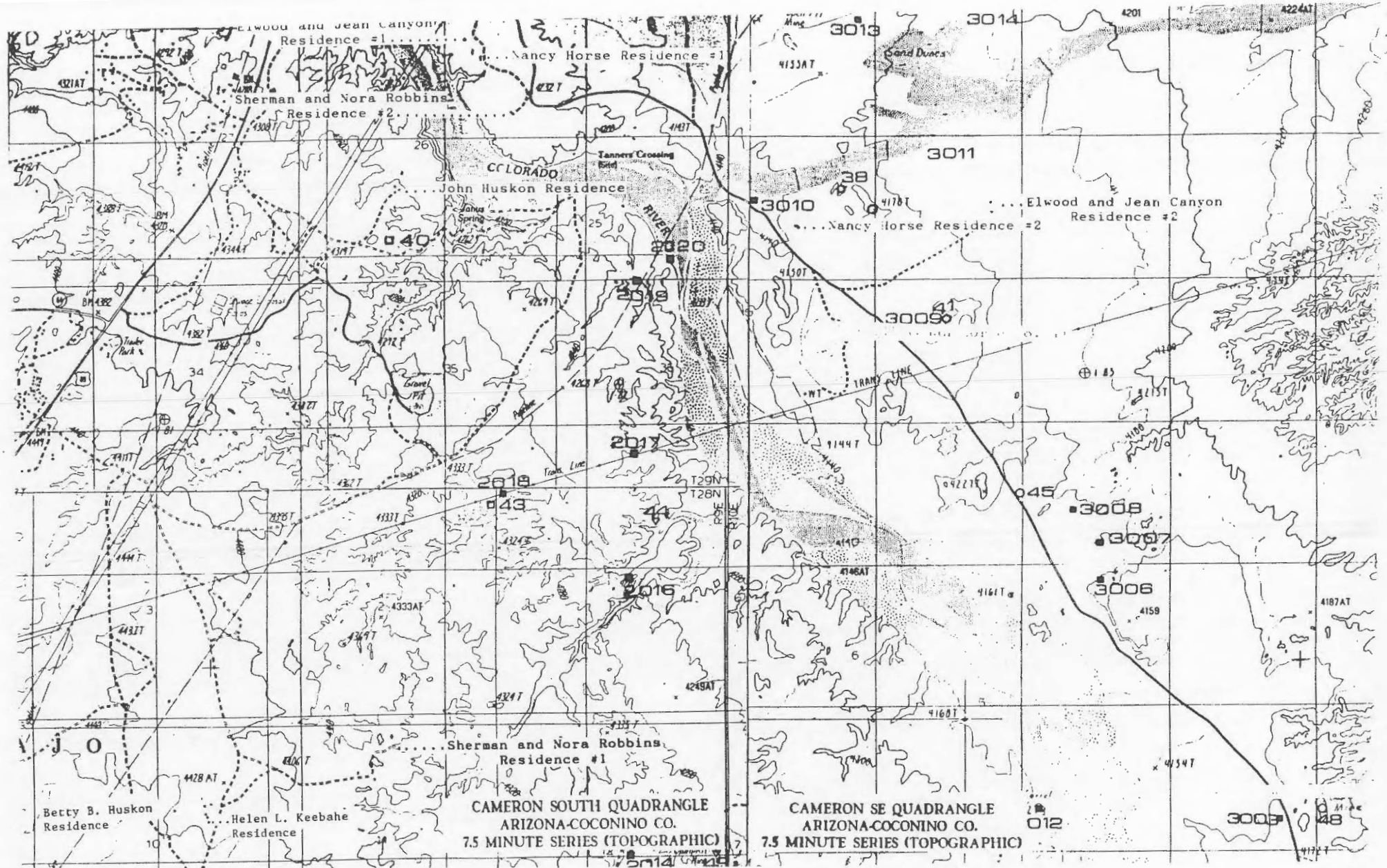
\_\_\_\_\_  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English \_\_\_\_\_ this 12th day of February 1993, 19 \_\_\_\_ . (check where applicable)

[Signature]  
Field Agent Signature

AA/bt.738



FORM A  
(Land User Consent)

Consent to Entry for Reclamation

Cameron Project

The Navajo Abandoned Mine Lands Reclamation Department (NAMLRD) proposes to perform reclamation work under the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1231, et seq., and the Navajo Abandoned Mine Lands Reclamation Code of 1987, CN-57-87, to protect the health, safety and general welfare of the public from the adverse effects of past mining activities.

I, NORA Robbins, give consent to the NAMLRD to enter onto my land use area and do all things necessary to reclaim abandoned mines thereon.

My land use area is located near/at Tsenáánushtí and is more particularly described on a map attached hereto as Exhibit "A".

In consideration for the restoration of abandoned mines located on my land use area, I agree to the following terms and conditions:

1. I agree to waive any rights to compensation for the diminishment in value to my land use rights that may occur as a result of the project.
2. I agree to cooperate with NAMLRD to facilitate the completion of the project.
3. I agree not to hinder, interfere with or obstruct the completion of the project.
4. I agree not to block access to my land use area.

5. Said right of entry is granted for the time required to complete the reclamation work.

6. Said right of entry shall include the right to temporarily store equipment and materials.

I certify that the terms contained in this consent form have been explained to me, and I fully understand the terms contained herein.

9/26/91  
Date

Shona Raluis  
Land User Signature  
(or Thumbprint)

77009  
Census No.

3-0644  
Permit No.

10/28/91  
Date

Sharon S. Sautter  
Grazing Committee  
or Land Board Member

3-int-1  
District No.

11/18/91  
Date

Meritt  
Director of NAMLRD

#### ACKNOWLEDGMENT OF FIELD AGENT

I acknowledge that the contents of this consent form were explained to the land user in Navajo ☒ or English \_\_\_\_\_ this 26th day of September, 1991 (check where applicable)

Jay Polk  
Field Agent Signature







## **APPENDIX E**

### **HEALTH PHYSICS AND INSTRUMENTATION MONITORING PLAN**

## TABLE OF CONTENTS

1. INTRODUCTION
2. ORGANIZATION AND RESPONSIBILITIES
  - 2.1 Organization and Structure
3. OPERATIONAL HEALTH PHYSICS AND ENVIRONMENTAL MONITORING
  - 3.1 Standards
    - 3.1.1 Personnel Exposure Standards
      - 3.1.1.1 Direct Exposure
    - 3.1.2 Environmental Reclamation Guidelines and Decontamination Standards
    - 3.1.3 General Public
  - 3.2 Personnel Monitoring
    - 3.2.1 Dosimetry
      - 3.2.1.1 Thermoluminescent Dosimeters (TLD)
    - 3.2.2 Bioassay
    - 3.2.3 Personnel Radon Monitoring
    - 3.2.4 Control Monitoring
  - 3.3 Radiological Control Monitoring
    - 3.3.1 Routine Surveys
    - 3.3.2 Boundary Establishment and Posting
    - 3.3.3 Protective Clothing
    - 3.3.4 Respiratory Protection
    - 3.3.5 Personnel Monitoring
    - 3.3.6 Equipment Monitoring and Surveys
    - 3.3.7 Transport of Contaminated Materials
    - 3.3.8 Decontamination
    - 3.3.9 ALARA Considerations
  - 3.4 Environmental Monitoring
    - 3.4.1 Background Environmental Monitoring
  - 3.5 Emergency Response
    - 3.5.1 Responsibilities
4. RADIOLOGICAL SUPPORT PROCEDURES AND MEASUREMENTS
  - 4.1 Initial Inventory Surveys
  - 4.2 Characterization Surveys
    - 4.2.1 Gamma Radiation Surveys (surface)
    - 4.2.2 Gamma Radiation Surveys (sub-surface)
    - 4.2.3 Gamma Radiation Surveys (haulroads)

4.2.4 Air Samples

4.3 Surveillance and Response during Construction

4.3.1 Gamma Radiation Exposure Rates

4.3.2 Air Samples Surveys

4.3.3 Contamination Surveys

4.3.4 Excavation Control Monitoring

4.3.4.1 Gamma Radiation Scans

4.3.4.2 Post Excavation Gamma Rad Scans

5.0 QUALITY ASSURANCE DOCUMENTATION AND REPORTING

5.1 Dosimetry Program

5.1.1 Detailed Procedure

5.1.1.1 Site TLD Issuance

5.1.1.2 Record Keeping

5.1.1.3 Exchange of TLD

5.1.1.4 Lost TLD's

5.1.1.5 Wearing TLD

5.1.1.6 Exposure Limits

5.1.1.7 Alert System

5.1.1.8 Storage of TLD

5.2 Operational Monitoring Records

5.2.1 Personnel

5.2.1.1 Daily Records

5.2.1.2 Long Term Records

5.2.1.3 Complaints

5.3 Vehicle, Equipment and Personnel Logs

5.4 Calibration Records

5.5 Radiological

5.5.1 Personnel Records

5.5.2 Instrument Records

5.5.3 Procedures

5.5.4 Surveys

## Appendix A: Guideline for Instrumentation and Health Physic Procedures

- A.1 Instrument Selection
- A.2 Frisking
- A.3 Loose Surface Contamination Surveys
- A.4 Air Sampling Procedures
- A.5 Instrument Calibration
- A.6 Radiological Instrument Functional Checks
- A.7 Dosimetry Program
- A.8 Decontamination of Personnel and Equipment
- A.9 Auguring and Gamma Logging of Boreholes
- A.10 Borrow Material Radioactive Screening
- A.11 Excavation Control Procedures
- A.12 Radiological Quality Assurance Procedures
- A.13 Respiratory Protection Program
- A.14 Emergency Preparedness Policy

# **HEALTH PHYSICS AND INSTRUMENTATION MONITORING PLAN ABANDONED MINE LANDS RECLAMATION DEPARTMENT**

## **1.0 INTRODUCTION**

This Health Physics and Instrumentation Monitoring Plan describes the methods to be employed for Health Physics monitoring and protection at abandoned uranium mine land sites. Specific restrictions are given when necessary. However, these guidelines are generic in nature and allows for evaluations of site specific conditions. The Navajo Abandoned Mine Land Reclamation Department, in coordination with the Office of Surface Mining Reclamation and Enforcement (OSMRE), U.S. Department of Interior, has the authority and responsibility to reclaim mine lands left abandoned or inadequately reclaimed on the Navajo Reservation prior to August 3, 1977.

This Health Physics and Instrumentation Monitoring Plan is intended as a guideline document, summarizing techniques and instrumentation to be applied at all Non-coal AML Reclamation Project areas. The Project Manager shall be ultimately responsible to ensure adherence to this policy document. The Project Manager will review the contents of this policy documents with the Construction Supervisor and construction crew on an as-needed basis. This plan is divided into four major sections:

- a) Operational Health Physics and Environmental Monitoring; describing worker and public health protection procedures;
- b) Radiological Support Procedures and Measurements; describing procedures to be used in defining contaminated areas and in verifying the effectiveness of remediation;
- c) Quality Assurance Documentation and Reporting;
- d) Appendices, Guidelines for Instrumentation and Health Physics Procedures.

## **2.0 ORGANIZATION AND RESPONSIBILITIES**

### **2.1 Organization and Structure**

Lines of authority for Health and Safety management must be independent of those for operational management to assure Navajo AML Health and Safety functions are not over ridden by operational concerns.

Responsibilities of the Navajo AML Reclamation Department are:

Department Director

The Department Director shall maintain communication with all personnel concerning administrative and technical matters. The Department Director shall have the final approval and/or concurrence concerning the



application of this Monitoring Plan. The Department Director shall be notified immediately concerning all incidents.

#### Program Manager

The Program Manager shall have the authority to recommend for approval and/or concurrence of all health physic applications and procedures within their respective AML District.

#### Health Physicist

The Health Physicist shall be responsible for implementing and administering the Health Physic Monitoring and Instrumentation Plan. The Health Physicist shall advise the Department Director and Program Manager of issues concerning to radiological procedures and overall health physic applications. The Health Physicist shall be responsible for the health physic indoctrination training.

#### Project Manager

The Project Manager shall be responsible for managing and planning the daily operations of the construction projects. The Project Manager shall orientate or schedule training for the construction staff on mine safety, OSHA standards, First Aid, CPR and protective equipment apparel. Shall submit updated reports to the Program Manager.

#### Construction Supervisor

The Construction Supervisor shall coordinate construction activities according to the Project Manager's directions. The Construction Supervisor shall submit updated reports to the Project Manager on all construction activities and maintain an daily log of all events.

#### Construction Staff

The Construction Staff shall have good knowledge of mine safety, OSHA standards, First Aid, CPR, Personal Protective Equipment, Health Physic, and Personnel Policy Manual prior to the commencement of construction activities.

### **3.0 OPERATIONAL AND ENVIRONMENTAL HEALTH PHYSICS**

#### **3.1 Standards**

The radiological guidelines and procedures in this document are based on regulations developed by the following agencies:

- a) U.S. Environmental Protection Agency (EPA);

- b) National Council on Radiation Protection and Measurements (NCRP);
- c) International Commission on Radiological Protection (ICRP) and,
- d) U.S. Nuclear Regulatory Commission (NRC).

All reasonable precaution shall be taken to ensure the health and welfare of all workers and the general public. The standards reference in this Plan are to considered minimum standards required for compliance.

### 3.1.1 Personnel Exposure Standards

#### 3.1.1.1 Direct Exposure

The major purpose of this section is to provide minimum standards when met, assures that satisfactory control is exercised over personnel radiation exposure and radioactive contamination. All personnel exposure to radiation will be kept **As Low As Reasonable Achievable (ALARA)**. At all times, Health Physics operation shall be conducted to ensure that a worker will not accrue a dose exceeding the limits specified in Table 2.1 Worker Maximum Exposure Standards.

**Table 3.1 Worker Maximum Exposure Standards**

<u>Type of Exposure</u>	<u>Exposure Period</u>	<u>Dose Equal Commitment REMS</u>
Whole body, head and trunk, gonads, lens of eye, red bone marrow, active blood-forming organs.	YEAR	5
	Calendar Quarter	3
Unlimited areas of the skin (except hands and forearms). Other organs, tissue and organ system (except bone).	YEAR	15
	Calendar Quarter	5
Bone	YEAR	30
	Calendar Quarter	10
Forearm	YEAR	30
	Calendar Quarter	10
Hands	YEAR	75
	Calendar Quarter	25

To ensure that these limits are not exceeded, administrative control levels as indicated below will be adhered to. No worker will be allowed to exceed 90 percent of the quarterly or annual limit, except in an emergency situation.

An individual under age 18 shall neither be employed in, nor allowed to enter radiological contaminated areas. Administrative Control Levels - Code of Federal Regulations, Chapter 10 Part 20, Standards for Protection Against Radiation, Section 20.105:

- Whole Body Exposure in unrestricted areas not to exceed 0.5 REM in any calendar year.
- Whole Body Exposure in unrestricted areas not to exceed 2 milli REM (mR) in any one hour period.

### **3.1.2 Environmental Reclamation and Decontamination Standards**

In the absence of Federal, State or Tribal standards, the Navajo AML Reclamation recommends environmental guidelines for cleanup of open lands contaminated with residual radioactive materials from abandoned uranium mines:

The concentration of Radium-226 in land shall not exceed 25 pico curies per gram (pCi/g) above natural background level. An additional guideline of 50 micro roentgen per hour (uR/hr) above natural background at one meter above ground level shall not be exceeded for true exposure rate values. These guidelines are secondary in cases where reclamation of an project area prove economically impossible and/or in situations where worker protection will be seriously jeopardized.

The U.S. NRC Guidelines for decontamination of facilities and equipment for unrestricted use are as follows:

Gross alpha activity for allowable levels of total removable set at 1,000 disintegration per minute per 100 centimeters square (dpm/100 cm<sup>2</sup>).

### **3.1.3 General Public**

Every attempt will be made to prevent or minimize project related radiation exposure to the general public. Although it is unlikely that significant exposure will occur, the guidelines for administrative control levels will apply for purposes of evaluating such exposure.

## **3.2 Personnel Monitoring**

Personnel monitoring will be required at all Project Area locations and at other locations deemed necessary by the Health Physicist and/or Program Manager.

### **3.2.1 Dosimetry**

All site personnel expected to access to project sites for more than the time periods specified in the Health Physic Procedures will be issued a radiation dosimeter badge. Storage of the dosimeter badge will be in low background area when not in use. Dosimeter badge will be exchanged quarterly and dosimetry records will be reviewed and updated by the Health Physicist.

#### **3.2.1.1 Thermoluminescent Dosimetry**

Personnel requiring access to sites and contaminated areas for more than 40 hours for field personnel and/or 120 hours for administrative personnel in any three consecutive months shall be issued a thermoluminescent dosimeter (TLD) badge. Such personnel shall receive a minimum of four (4) hours of health physics indoctrination training. Project Managers shall be responsible to inform the Health Physicist the need for additional TLD's badges for field personnel.

TLD's shall be exchanged quarterly and read by the issuing vendor. A unique TLD Number shall be assigned to each individual. Control TLD's shall also be read quarterly.

### **3.2.2 Bioassay**

Bioassay specimen requirement shall not be enforced due to the levels of radioactivity encountered and documented. This shall be subject to change on a case by case basis, at the discretion of the Health Physicist who is responsible for review and action regarding bioassay data upon receipt.

### **3.2.3 Personnel Radon Monitoring**

Where the potential exist for exposure of workers to significant concentration of Radon-222 and decay products, provision shall be made to monitor such exposure. Depending upon the anticipated exposure, the following monitoring procedure may be employed at the discretion of the Health Physicist:

- \* Routine grab sampling for radon and/or decay products in close proximity to exposed workers.

### **3.2.4 Control Monitoring**

Areas having the potential for continuous occupancy, and which exceed 50 micro roentgen per hour (uR/hr), 25 pico curies per gram (pCi/g) of Radium-226 in soil or areas in which more than 1,000 disintegration per minute per 100 centimeter square including natural background of transferable surface contamination exist are to be considered contaminated

areas. These areas are to be posted at points of potential access with signs bearing the radiation caution symbol and an appropriate warning.

Project areas designated shall be monitored for access of personnel, vehicles and equipment. Monitoring will vary from site to site depending on the magnitude of contamination and duration of the job. Access to these sites will be controlled by barrier, signs or other methods of control to prevent inadvertent exposures. Smoking, drinking, chewing and eating are prohibited in contaminated areas.

### **3.3 Radiological Control Monitoring**

#### **3.3.1 Routine Surveys**

Routine gamma surveys will be required in specific work areas to determine and update exposure rate to workers. These surveys will be recorded on a diagrammatic sketch of the work area and will be color-coded according to specific levels of contamination. Radiological monitoring involves those measurements, surveys and samples used on a daily basis to identify potential radiation hazards and to indicate the existence of radioactive contamination.

Gross alpha air concentration evaluation may be required in work areas where airborne levels may exceed maximum permissible concentration (MPC) per week. These levels measured in air may be compared to the Thorium-230 occupational MPC in air from 10 Code of Federal Regulation, Part 20, Appendix B, Table 1.

#### **3.3.2 Boundary Establishment and Posting**

Health physic personnel will establish boundaries around project areas to be controlled for protection of workers and the general public from unnecessary radiation exposure and to prevent the spread of radioactive contamination.

Areas include, but are not limited to, any work areas which meet the following conditions above natural background:

- Significant portions of potentially expose surface contamination exceeding 25 pCi/g of Radium-226.
- Areas having gamma radiation exposure rates exceeding 50 uR/hr.
- Transferable surface contamination is likely to exceed 1,000 dpm/100cm<sup>2</sup>.

Areas defined above must be conspicuously marked at points of potential access with signs bearing the radiation caution symbol and the words:



## **CAUTION**

### **RADIOACTIVE MATERIAL**

All applicable posting and labeling requirements set forth in 10 CFR 20 must be followed.

#### **3.3.3 Protective Clothing**

Coverall (disposable) will be worn by workers expected to contact significant quantities of contaminated material or contaminated dust generated by construction operations. Rubber boots and/or gloves will be required depending on weather and/or work conditions. The Project Manager shall be responsible to provide the safety apparel.

#### **3.3.4 Respiratory Protection**

Respiratory protection will be required for all individuals working in areas with potentially airborne contaminated dust. A determination of physical ability to wear a respirator shall be required for all personnel using respiratory protection. The efficiency level of respiratory protection shall be determined by the Health Physicist. The Project Manager shall be responsible to provide this equipment.

#### **3.3.5 Personnel Monitoring**

All individuals exiting from contaminated areas will be monitored for alpha contamination in areas that exceed levels specified under Section 2.1.2. Environmental Reclamation and Decontamination Standards. The monitoring will be conducted with an alpha scintillation probe and meter. Measurable contamination will be removed. Gamma surveys will be performed to establish exposure rates for health physics monitoring purposes.

#### **3.3.6 Equipment Monitoring Surveys**

Gamma radiation surveys will be performed on all equipment and vehicles to locate potential surface contamination.

All contaminated equipment, tools and vehicles will be surveyed prior to release from the project area.

The survey will consist of monitoring with a portable survey instrument, and if necessary, a smear for loose contamination. The equipment will be held for decontamination and resurveyed for levels exceeding 1,000 dpm/100cm<sup>2</sup>. All trucks hauling contaminated materials on improved dirt roads will be tarp and have a sealed tailgate to prevent spillage of contamination during transport.

### **3.3.7 Transport of Contaminated Materials**

Navajo AML Reclamation Department and its contractors shall comply with the applicable Federal, State and Tribal regulations regarding the transportation of contaminated materials. Site specific determination of the levels of radioactivity associated with the abandoned uranium mine and contaminated waste materials shall be made. If levels do not exceed 2,000 pico curies per gram (pCi/g), the materials does not meet the Department of Transportation's definition of "Radioactive Materials", and trucks are not required to be placarded. Trucks hauling on public roads shall be tarped at all times and have a sealed tailgate to prevent spillage. All visible contaminated materials shall be removed from the exterior before transporting.

### **3.3.8 Decontamination**

Skin contamination will be removed by using lukewarm water and soap or mild nonabrasive detergent. Contaminated equipment will be decontaminated by scraping, brushing, washing and wiping.

### **3.3.9 ALARA Considerations**

All reasonable effort will be made to keep radiation exposure, as well as radioactive material to unrestricted areas as far below the limits specified in 10 CFR 20 as is reasonably achievable. Time, distance and shielding factors should be practiced. Surveillance, including audits and inspections will be required. Personnel will be trained in radiation safety procedures and ALARA philosophies to a level commensurate with their scope of work.

## **3.4 Environmental Monitoring**

### **3.4.1 Background Environmental Monitoring**

These measurements will be performed to determine natural and project area background values and will include the following:

- \* Gamma radiation dose rate upwind and distant from the project area.
- \* Equivalent Radium-226 soil concentration
- \* Radon 222 air concentration where applicable.

## **3.5 Emergency Response**

The purpose of this section is to:

- \* Protect lives, property, public health and safety.
- \* Maintain continuity of management.
- \* Maintain essential operations.
- \* Effectively utilize personnel under conditions of radiological, operational, natural and other emergencies.

The responsibilities of the Health Physicist, Project Manager and Construction Supervisor and contractors are as follows:

- \* Report an actual or potential emergency upon discovery.
- \* Evacuate personnel promptly from immediate danger area.
- \* Take action to correct the situation.

Serious accidents shall be investigated by the Tribal, Federal, State or local authority having environmental, health and safety jurisdiction.

#### **4.0 RADIOLOGICAL SUPPORT PROCEDURES AND MEASUREMENTS**

This section provides a discussion of procedures and measurements required of Health Physic staff to support evaluation phases from inventory, site characterization, construction and post construction monitoring and additional activities as required. Excavation and remediation construction activities will be guided by Health Physic personnel in a timely efficient manner consistent with the need to proper and safe remediation.

##### **4.1 Initial Inventory Surveys**

Prior to commencement of significant construction activities in a particular area, a gamma ray radiation surface survey will be conducted by Health Physic personnel using a predetermined grid pattern in an effort to effectively cover the project area in it's entirety. Portable Sodium Iodide (NaI) instrumentation will be employed, and a general map indicating the mine site vicinity including the mine, waste piles, protore piles, structures on site, surface water drainage, location of site background measurements, areas significantly in excess of background gamma radiation levels and any additional information needed to support for inclusion for remediation.

After completion of initial activities in such areas, and periodically thereafter, exposure rate surveys using calibrated field instruments will be conducted to establish the location of contamination for purposes of Health Physic exposure control.

##### **4.2 Characterization Surveys**

###### **4.2.1 Gamma Radiation Surveys (surface)**

Surface characterization surveys employed will define gamma radiation contamination levels by collecting surface and one meter above ground level (agl) readings. Delta surveys shall be conducted when "shine" from nearby low grade ore piles, waste material and/or naturally occurring material influence and interferes with the performance of the outdoor gamma survey.

#### **4.2.2 Gamma Radiation Surveys (sub-surface)**

In addition to surface gamma surveys, areas gamma readings specified under Section 2.1.2 will be augured and boreholes logged using a gamma detection probe coupled with a portable rate meter. Gamma measurements will be taken at six (6) inch increments to quantify the contamination depth.

#### **4.2.3 Gamma Radiation Surveys (haulroad)**

Prior to construction of a haulroad, a surface gamma survey will be conducted utilizing calibrated portable gamma radiation detection instrument. Data will be mapped and color coded indicating gamma exposure levels significantly in excess of background to guide initial soil and material removal during haulroad construction.

After completion of the haulroad, and periodically during construction activities, gamma surveys will be routinely conducted to ensure that no significant and additional contamination of the road has occurred.

#### **4.2.4 Air Samples**

Portable high volume air samples will be used to collect breathing zone air particle sample in contaminated areas. Samples will be taken during periods of major activity and analyzed for gross alpha and additional monitoring for Thorium-230. Actual isotopic concentration of Thorium-230 may be utilized to help interpret worker exposure as indicated by the gross alpha analyses.

### **4.3 Surveillance and Response during Construction**

#### **4.3.1 Gamma Radiation Exposure Rates**

Calibrated, portable gamma radiation detection instruments will be used to routinely measure area radiation exposure rates. Initial readings will be taken in the areas occupied by workers to characterize gamma radiation field which they are exposed. During excavation activities, area gamma radiation exposure rate surveys will be conducted on a routine basis and frequency of these surveys should commensurate with anticipated changes in gamma exposure levels.

#### **4.3.2 Air Sample Surveys**

Area air samples will be taken in each designated area on the site and of associated property with calibrated hi-volume air samplers at least twice per shift during excavation of large volumes of contaminated material or more samples taken during unexpected situation should they rise. Air samples will be counted with an alpha detection system capable of detecting gross alpha.

Whenever, dust is generated within a contaminated area, or whatever significant concentration of airborne particulate or gaseous radionuclides are measured at the project area and associated properties, measures must be implemented to reduce such concentrations. In severe cases as windstorms, the Project Manager shall plan to control release of radioactive dusts or suspend work to limit exposure to personnel.

#### **4.3.3 Contamination Surveys**

Survey of areas for loose contamination will be performed by taking smears from the floor areas, desk tops, etc., on a routine basis. Loose alpha contamination exceeding 1,000 dpm/100cm<sup>2</sup> will require documentation of the area. Smears of loose contamination will be counted with alpha, and/or beta-gamma detection system capable of detecting gross alpha and beta-gamma below levels for unrestricted release. Routine smears will be taken in office areas and on semi-permanent support equipment.

#### **4.3.4 Excavation Control Monitoring**

##### **4.3.4.1 Gamma Radiation Scans**

During excavation, health physic personnel will employ portable detectors to locate residual contaminated material by gamma-ray emissions. Where gamma radiation levels due to interfering contaminated material are excessive, shielded detectors or other method, such as soil sampling, shall be employed to guide excavation.

##### **4.3.4.2 Post Excavation Gamma Radiation Scans**

Hauling routes and access points will be routinely spot surveyed with a gamma detector to ensure that transfer of contaminated material is being carried out in a controlled manner. This data will be composed to initial survey readings, at the completion of decontamination.

### **5.0 QUALITY ASSURANCE DOCUMENTATION AND REPORTING**

This section of the Health Physic Monitoring and Instrumentation Plan is design to ensure that radiological instrumentation and procedures, documentation and reporting are in compliance for Quality Assurance purposes.

#### **5.1 Dosimetry Program**

The following section describes the personnel monitoring program which shall be utilize to provide the legal record for personnel exposure to external ionizing radiation during employment. This procedure sets forth the methodology of issuance, administration, and record keeping for thermoluminescent dosimeter (TLD) badges, the devices that provide radiation exposure estimates for individual



permanent records. Additional procedures are in Appendix A., A-1 Dosimetry Program.

#### **5.1.1 Detailed Procedure**

All personnel who require routine access to other radiologically contaminated areas shall be issued a TLD prior to entry into these areas with a minimum of four hours of initial indoctrination health physic training.

##### **5.1.1.1 Site TLD Issuance**

All personnel requiring TLD's for the performance of their jobs shall have received the appropriate level of radiological training necessary for their work. The training should commensurate with the anticipated work hazard, include discussion of AML Projects, industrial and radiological safety procedures, ALARA philosophy, emergency procedures and the potential for encountering hazardous materials on the project area.

This requirement may be waived for personnel who will spend limited time in areas requiring TLD's for entry, but who are not considered to be part of the normal work crew associated with that site, if by virtue of their job title, they may be expected to have the radiological knowledge necessary for the purpose of entering contaminated areas.

Temporary non-construction personnel and visitors are excluded from TLD requirements. Visitors shall be escorted at all times by the Health Physicist, Project Manager or Construction Supervisor while in contaminated areas.

##### **5.1.1.2 Record Keeping**

The Project Manager shall establish and maintain a log/personnel file for all individuals issued TLD's.

At the end of the specific project, the Project Manager shall send all dosimetry files to the Window Rock central office for review and permanent file.

##### **5.1.1.3 Exchange of TLD**

The Health Physicist shall establish quarterly exchanges of TLD's through the coordination with the supplying vendor. If all possible, TLD's shall be exchanged on the same day.

A unique TLD ID number shall be assigned to each individual utilizing a TLD. This ID number shall be the same for each individual for the length of a project.

When exchanged of TLD's is completed, TLD's shall be delivered or shipped immediately to the supplying vendor for processing, including all controls and unissued TLD's.

#### **5.1.1.4 Lost TLD's**

The Health Physicist shall conduct an investigation of all incidents of lost TLD's to determine corrective actions that may be taken to prevent recurrence.

#### **5.1.1.5 Wear TLD's**

TLD's shall be worn on the front of the body between the neck and waist unless otherwise dictated by the Health Physicist. Additional dosimetry may be required, excepting extremity dosimetry, should be worn adjacent to the TLD.

#### **5.1.1.6 Exposure Limits**

Dose limitation standards for personnel and the general public are listed under Table 2.1 Radiation Worker Maximum Exposure Standard set forth the allowable radiation exposure limits on a quarterly and annual basis. As an additional safeguard, the Health Physicist may impose a more stringent administrative exposure control limits.

#### **5.1.1.7 Alert System**

The Health Physicist shall establish and maintain an "alert" list for personnel whose radiation exposure are approaching the administrative limits and to minimize the probability of the individual receiving radiation exposure in excess of the limits.

#### **5.1.1.8 Storage of TLD's**

The Project Manager shall establish and maintain a centrally located dosimetry issue station. TLD's shall be dispensed from this station on a daily basis. Construction supervisor may pick up TLD's, if needed, for their crews from the station and distribute them at the work site. TLD's shall be returned to the dosimetry station at the end of each work day by the employee or construction supervisor. Control and unissued TLD's shall be kept at the dosimetry station or in a low background area.

### **5.2 Operational Monitoring Records**

#### **5.2.1 Personnel**

#### **5.2.1.1 Daily Records**

A daily record of access point monitoring activities shall be maintained by Health Physic personnel. If contamination is detected, it shall be documented. The record shall include name and social security number of the individual, body location and activity level discovered, action taken to remove contamination (washing, removal of clothing) and results of subsequent frisk.

#### **5.2.1.2 Long-Term Records**

A worked related radiation exposure history shall be acquired and maintain for each employee. Permanent record of visitors and radiological exposure shall be maintain at the Field Offices and Window Rock central office for future reference. Due to the nature of confidential information, limited records shall be kept at the Project Area.

The following records shall be maintained in this file:

- \* Personal information
- \* Radiological training verification
- \* USNRC Form 4
- \* Bioassay data
- \* Request for previous radiation history
- \* TLD issue form with cumulative exposure
- \* Lost TLD badge report

#### **5.2.1.3 Complaints**

Employees are encouraged to report, through their supervisors any conditions or practices they consider detrimental to their health and safety they believe are in violations of applicable health and safety standards. Such complaints may be provided in oral or written form.

### **5.3 Vehicle, Equipment and Personnel Logs**

Radiation Monitoring Logs will contain notation (time and date), and a summary of any significant or unusual contamination found, levels, action taken and final survey results.

### **5.4 Calibration Records**

Health Physics instruments employed in reclamation clean-up activities shall be calibrated by an approved vendor on an annual basis. In addition, instruments determined to exhibit incorrect or erratic behavior shall be repaired and calibrated.

Permanent record of calibration results, including documentation received from servicing vendors shall be maintained for future reference.

## **5.5 Radiological Project Files Organization**

These project files shall be maintained at the Window Rock central office with copies at the Field Office which includes:

### **5.5.1 Personnel Records - a folder for each person including:**

- \* Training documentation
- \* Exposure history
- \* Personal data form
- \* Signed "Instruction regarding the Unborn Fetus" form, National Commission on Radiation Protection Report 39 Recommendation
- \* Other pertinent information, updated doses on a quarterly basis, medical exams, etc.

### **5.5.2 Instrumentation section including:**

- \* Instrument specific user manual, calibration data, voltage plateau information, functional check information, etc.
- \* Equipment/Tool identification list

### **5.5.3 Procedure section**

- \* Master copy of current procedures
- \* Procedure changes

### **5.5.4 Surveys**

Separate sections for air sampling and radiation surveys, information for each section should include: numbering system, routine sampling locations, weekly, monthly and quarterly averages for each location.